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FULVOUS TREE-DUCK

DENDROCYGNA BICOLOR

One-half natural size

Painting by Andrew Jackson Grayson

THE CONDOR

VOLUME 53 JANUARY-FEBRUARY, 1951 NUMBER 1

CONGENERIC SPECIES OF BIRDS NESTING TOGETHER IN CENTRAL AMERICA

By ALEXANDER F. SKUTCH

Evolutionary theory leads us to believe that a genus is a monophyletic group, all its component species having sprung from a common ancestral stock. Indeed, proof that any genus, as currently recognized, did not fulfill this condition would provide a basis for its division. Whenever the bird fauna of a certain locality is studied, it is found that in many instances several species of a single genus intermingle in the same breeding area. For a long time this has been a challenging problem to the naturalist. In the early discussions of the subject, during the nineteenth century, the phenomenon was frequently cited as evidence for physiological or sympatric speciation, that is, the division of a single local population into two or more non-interbreeding groups sharing a common area. This theory, which was based on the concept of blending inheritance, finds so many obstacles in the Mendelian theory of inheritance that it has only few adherents today. It is now held to be much more likely that such similar species originated in geographical isolation, but have come together at a subsequent date through the extension of the area occupied by one or more of them (Mayr, 1942, 1947).

The problem of congeneric species nesting together has, however, by no means lost its attractiveness as a result of the rejection of the theory of sympatric speciation. It is now realized that the real problem is not how these species originally split into two, but rather what keeps them distinct, now that they have come together again. All the various biological factors which help to maintain the distinctness of species and to prevent interbreeding have been labelled isolating mechanisms by Dobzhansky (1941). The study of congeneric species nesting together is thus really a study of isolating mechanisms.

Most important among them are probably those characters which are directly connected with pair formation, such as external morphology and plumage pattern, song and call notes, and finally displays and courtship motions. However, as Lack (1944) has recently emphasized, an overlapping of the ranges of closely related species takes place usually only when ecological differences between the two species have developed in regard either to food or habitat preference. Such ecological differences not only decrease the amount of competition between such species but also reduce the number of contacts between unmated birds of different species and thus also help to prevent interbreeding.

The purpose of the present paper is, first, to place on record the instances of congeneric species breeding in the same area that have come to my attention in Central America; second, to try to discover what keeps such species from interbreeding; and finally, to discover some of the differences in habitat preferences. In table 1 information is given for twenty-nine groups of two, one group of three, and one group of four, congeneric species that I have found nesting in the same area or in contiguous or overlapping habitats.

I have omitted the trogons from this discussion. In this family it is difficult to steer a safe course between the shoals of lumping and the reefs of splitting. If I follow the somewhat narrow generic concepts of Ridgway (1911), I have no records of congeneric

species of trogons nesting together. If, on the contrary, I follow the older as well as some more recent authors and place in the single genus *Trogon* all the Central American members of the family, save only *Pharomacrus mocinno*, then there are a number of records of congeneric species nesting together. But by this course we place in the same genus species whose nests differ more fundamentally in form than those of any two species that have been treated as congeneric in this paper.

When more than a single pair of species is listed in table 1 under the generic name, the brackets indicate which were found nesting in proximity. Most of the species considered together occupy the same habitat; but in a few instances species of adjoining habitats have been placed in juxtaposition for the purposes of comparison. Even among the non-migratory species of the tropics, birds frequently make short excursions beyond their normal haunts; they often place their nests at the edge of the vegetational formation in which they dwell, or even beyond it, forest birds at times entering the neighboring clearings to build their nests and lay their eggs. Thus, birds of quite different preferences as to habitat often meet; and were there any strong tendency for them to hybridize, they would have ample opportunity to do so. It is not inconceivable that a bird of open country should mate with a bird of the forests and the two place their nest where field and forest meet.

The discovery of nests amid the heavy vegetation of the tropics is notoriously difficult. Observation of the habits during the breeding season of a number of pairs of congeneric species not listed here makes me feel sure that they nest in the same area; but it seems best to include in this discussion only species whose nests have actually been found in the same neighborhood. In a few instances the nests of the species bracketed together were two or three miles apart; but in the great majority of cases the two species were found nesting within a mile of each other; and often their nests were in the same dooryard, in the same bank, or even in the same tree. I feel confident that the discovery of a greater number of nests would show that all the species bracketed together breed at times within a few hundred feet of each other, for they intermingle during the season of reproduction. When the vast Central American avifauna is as thoroughly known in its biological as in its taxonomic aspects, it will be possible to compile a far longer list of congeneric species that breed together.

The present record is based upon field work during fourteen nesting seasons, in Guatemala, Honduras, Panamá, and chiefly Costa Rica. The nomenclature employed in the table is that of Cory and Hellmayr's "Catalogue of the Birds of the Americas" (1918-1938) except in the single instance of the genus *Phaethornis*, where Peters (1945) has been followed. The localities where the observations were made are indicated by the capital letters opposite the brackets at the left side of the table, in accordance with the following schedule, which is that followed in my paper (1945:14) on incubation and nestling periods:

A—El General, head of Térraba Valley, southern Pacific Costa Rica.
B—Vicinity of Vara Blanca in the Costa Rica highlands, on the Caribbean slope at 5000 to 6000 feet above sea level.
C—Caribbean Costa Rica, at lower elevations.
D—Caribbean Honduras, near Tela.
E—Los Amates, humid lower Motagua Valley, Guatemala.
F—Highlands of western Guatemala, Department of Chimaltenango, 7000 to 10,000 feet above sea level.
I—Almirante, western Panamá.
J—Barro Colorado Island, Canal Zone.
K—Near Cali, Colombia.

Many of these pairs of species that breed together come into contact over a vast extent of territory; hence there is no reason to suppose that their nesting in close proximity is a purely local condition. In other instances, a bird of great geographic extension meets and mingles with a congener whose homeland occupies only a small fraction of its own. Again, we have the interesting phenomenon of a wide-ranging species breeding alongside now one, now another, of two "representative species," that is, two quite similar species (members of the same superspecies) that may be thought of as representing each other in different areas. Instances of this are found in the genus *Troglodytes*, in which the wide-ranging *T. musculus*, the tropical House Wren, breeds in Guatemala in close proximity to *T. rufociliatus*, and in Costa Rica with the local representative of the latter, *T. solstitialis*. These little highland wrens are woodland birds, while the House Wren haunts the clearings. Yet in Guatemala I found *T. rufociliatus* and *T. musculus* nesting within hearing of each other in the same bank beside a road that led between woodland and pasture; while in Costa Rica, *T. solstitialis* and *T. musculus* nested in the same forest-encircled pasture. Similarly, the wide-ranging and common Blue Tanager (*Thraupis episcopus*) breeds in northern Central America with the Abbot Tanager (*T. abbas*), a "representative" of the Palm Tanager (*T. palmarum*), with which the first-mentioned nests in southern Central America. In Guatemala, *T. episcopus* and *T. abbas* nested in the same yard; in Costa Rica, *T. episcopus* and *T. palmarum* nested in the crown of the same cohune palm growing in a pasture.

In column four of table 1 is given the approximate altitudinal distribution of each species. These figures refer especially to the Central American portion of the bird's geographical range; where the species occurs also in México or in South America, it may have there rather different altitudinal limits. In most instances, the congeneric species that nest together have essentially similar altitudinal ranges—they are both lowland or both highland species—but one may occupy a broader vertical zone than the other. In a few cases, however, the altitudinal range of a lowland species overlaps that of a highland species, as may be seen in the genera *Elaenia, Myiodynastes, Troglodytes* and *Chlorospingus*.

In the fifth column, giving habitats, limitations of space make it necessary to characterize the vegetation in the most general terms. Usually the species bracketed together are both forest birds, or else both birds of the clearings and secondary vegetation; but they often differ in the density of the growth they prefer. Thus, in the genus *Leptotila*, the Rufous-naped Cassin Dove (*L. cassinii rufinucha*) frequents rather heavy, dense second-growth; while the Verreaux White-fronted Dove (*L. verreauxi verreauxi*) is at home in lighter, more open second-growth and fields with scattered trees, where one will seldom find the former. Yet there is a fairly broad zone in which their habitats overlap. So the Slate-headed Tody Flycatcher (*Todirostrum sylvia*) will be found in thickets too dense for its relative, *T. cinereum*, and the latter in shady pastures and dooryard shrubbery far too open for the former; yet along the edges of thickets the two often meet. Both of the little black manakins of the genus *Pipra* are at home in the high forest; but the scarlet-headed species, *P. mentalis*, displays and nests at somewhat higher levels of the understory than its blue-crowned relative, *P. coronata*.

The sixth column gives the breeding season for the Central American portion of the bird's range. In preparing this I have been aided by Harrower's (1936) comprehensive resumé of data on the breeding habits of the passerine birds of Central America. The nesting season of some of these birds appears to begin earlier, and to last longer, in Panamá than farther to the north. Unfortunately, the breeding seasons as given in this column are based on very unequal numbers of nests. In some instances, only one or two

Table 1

Examples from Central American Birds of Congeneric Species Nesting Together

Genus and species	Location	Range: Geographic	Range: Altitudinal	Habitat	Nests found	Comparison: Nest area	Comparison: Appearance	Comparison: Voice
PIGEONS, DOVES								
Columba								
nigrirostris	A	México—E. Panamá	0– 3000	Forest and clearings	Mch.-Apr.	Same	Very different	Very different
speciosa	A	S. México—Paraguay	0– 3000	Forest and clearings	Feb.-May			
Columbigallina								
passerina	K	S. U.S.A.—Paraguay	0– 8500	Open country	Jan. (1)	Same	Moderately different	
talpacoti	K	S. México—N. South America	0– 3500	Open country	Jan.-Aug.	Same	Very similar	
minuta	E	S. México—N. South America	0– 2000	Open country	May-June			
Leptotila								
cassinii	A	Guatemala—Colombia	0– 3000	Woodland	Mch.-Oct.	Overlap	Head different	Very different
verreauxi	A	S. Texas—Brazil	0– 8000	Thickets and clearings	Jan.-Sept.			
KINGFISHERS								
Chloroceryle								
amazona	E	S. México—Argentina	0– 3000	Water	Feb.-July	Same	Similar; striking difference in size	Very different
americana	E	S. U.S.A.—Argentina	0– 7000	Water	Mch.-May			
HUMMINGBIRDS								
Phaethornis								
longuemareus	A	México—South America	0– 4500	Forest and clearings	Nov.-July	Overlap	Similar; striking difference in size	Moderately different
superciliosus	A	México—Bolivia	0– 3000	Forest and edge	Jan.-May			
ANTBIRDS								
Myrmotherula								
axillaris	J	Honduras—Bolivia	0– 1500	Rain-forest	Apr.-May	Same	Very different	Moderately different
fulviventris	J	Honduras—W. Ecuador	0– 1500	Rain-forest	Jan.-May			
FLYCATCHERS								
Elaenia								
chiriquensis	A	S. Costa Rica—S. Brazil	0– 3500	Bushy pasture	Apr.-July	Overlap	Similar, but head different	Very different
flavogaster	B	S. México—N. Argentina	0– 6000	Open groves	Mch.-Aug.	Overlap	Similar, but head different	Very different
obscura	B	Guatemala—N. Argentina	4000– 8000	Shady pasture	Apr.-June			
Myiobius								
atricaudus	A	Costa Rica—Perú	0– 3000	Riverside thickets	Apr.-Aug.	Overlap	Very similar	
sulphureipygius	A	S. México—W. Ecuador	0– 3000	Rain-forest	Mch.-May			

Table 1 (Continued)

Examples from Central American Birds of Congeneric Species Nesting Together

Genus and species	Location	Range: Geographic	Range: Altitudinal	Habitat	Nests found	Comparison: Nest area	Comparison: Appearance	Comparison: Voice
Myiodynastes								
chrysocephalus	B	Costa Rica—Perú	3500– 6000	Cloud-forest	May (1)	Sometimes same	Moderately different	Moderately different
luteiventris	B	Arizona—W. Panamá	0– 6000	Open groves	Apr.-July	Sometimes same	Moderately different	Moderately different
Myiozetetes								
cayanensis	J	Panamá—S. Brazil	0– ?	Open country	Jan.-May			
similis	J, A, I	México—N. Argentina	0– 6000	Open country	Apr.-July	Same	Very similar	Different
granadensis	A, I	Honduras—E. Perú	0– 5500	Open country	Mch.-July	Same	Similar, head different	Very different
Todirostrum								
cinereum	A	S. México—Brazil	0– 4500	Open groves	Mch.-July			
sylvia	A	S. México—Brazil	0– 3000	Dense thickets	Apr.-July	Often join	Very different	Very different
MANAKINS								
Pipra								
mentalis	A	S. México—W. Ecuador	0– 3500	Rain-forest	Mch.-Jun.	Same	Similar, head different	Very different
coronata	A	S. Costa Rica—Perú	0– 3500	Rain-forest	Feb.-Jun.	Same	Similar, head different	Very different
COTINGAS								
Tityra								
inquisitor	A	S. México—N. Argentina	0– 3000	Forest and clearings	Apr.-May	Same	Similar, head different	Different
semifasciata	A	México—S. Brazil	0– 6000	Forest and clearings	Mch.-July	Same	Similar, head different	Different
WRENS								
Thryothorus								
modestus	A	S. México—Panamá	0– 6500	Low thickets	Jan.-Sept.	Adjoin	Very different	Very different
nigricapillus	A	E. Nicaragua—W. Ecuador	0– 3000	By rivers	Jan.-Aug.	Adjoin	Very different	Very different
Troglodytes								
rufociliatus	F	Guatemala—Salvador	7000–11000	Cloud forest	Apr.-July			
musculus	F, B	S. México—Patagonia	0– 9500	Open country	Dec.-Sept.	Overlap	Very different	Very different
solstitialis	B	Costa Rica—N. Argentina	4500– 8000	Cloud forest	Apr.-July	Overlap	Very different	Very different
THRUSHES								
Turdus								
assimilis	A	México—W. Panamá	1000– 6000	Forest and clearings	Mch.-Jun.	Overlap	Very different	Very different
grayi	A, B	México—Panamá	0– 8000	Open country	Mch.-Aug.	Overlap	Very different	Very different
ignobilis	B	S. México—South America	3000– 7000	Forest and clearings	May (1)	Overlap	Moderately different	Very different

Table 1 (Continued)

Examples from Central American Birds of Congeneric Species Nesting Together

Genus and species	Location	Range: Geographic	Range: Altitudinal	Habitat	Nests found	Comparison: Nest area	Comparison: Appearance	Comparison: Voice
WOOD WARBLERS								
Myioborus								
miniatus	B	México—Perú	2000– 7000	Forest and edges	Apr.-Jun.	Same	Very different	Very different
torquatus	B	Costa Rica—W. Panamá	3500– 9000	Forest and edges	Apr.-May	Same	Very different	Very different
FINCHES								
Saltator								
coerulescens	D	S. México—Paraguay	0– 5500	Open country	May-July			
maximus	D	México—Brazil	0– 5000	Open country	Mch.-Sept.	Overlap	Different	Very different
albicollis	A	S. Costa Rica—N. So. America	0– 3200	Open country	Mch.-Aug.	Overlap	Different	Very different
Sporophila								
aurita	C, D	S. México—S. Colombia	0– 5500	Grassland	Mch.-Sept.	Same	Very different	Moderately different
torqueola	C, D	S. U.S.A.—Costa Rica	0– 6000	Grassland	Apr.-Oct.	Same	Very different	Moderately different
TANAGERS								
Chlorospingus								
ophthalmicus	B	S. México-Argentina	1500– 8000	Forest and clearings	Apr.-Jun.	Same	Similar, head different	
pileatus	B	Costa Rica—W. Panamá	5500–10000	Cloud forest	Jun.-July	Same	Similar, head different	
Tanagra								
luteicapilla	A	Nicaragua—Panamá	0– 4000	Woods and clearings	Mch.-Jun.	Adjoin	Males very similar	Moderately different
imitans	A	S. Costa Rica—W. Panamá	0– 4000	Forest and clearings	Mch.-May	Adjoin	Females moderately different	Moderately different
minuta	A	Guatemala—Brazil	0– 5000	Forest and clearings	Apr. (1)	Adjoin	Females moderately different	Moderately different
Calospiza								
chrysophrys	A	Costa Rica—N. So. America	1000– 3500	Forest and clearings	Apr.-Jun.	Same	All four very different	All four very different
gyrola	A	Costa Rica—Bolivia	0– 4000	Forest and clearings	Feb.-Sept.	Same	All four very different	All four very different
icterocephala	A	Costa Rica—Ecuador	0– 4000	Forest and clearings	Apr.-Sept.	Same	All four very different	All four very different
nigro-cincta	J	S. México—N. So. America	0– 5000	Forest and clearings	Feb.-Sept.	Same	Very different	Moderately different
inornata	J	W. Panamá—Colombia	0– ?	Forest and clearings	Apr.-Aug.	Same	Very different	Moderately different
Thraupis								
abbas	E	S. México—N. Nicaragua	0– 5000	Open country	Mch.-May	Same	Very different	Very different
episcopus	A, J	S. México—Brazil	0– 7500	Open country	Jan.-July	Same	Very different	Very different
palmarum	A, J	S. Nicaragua—Bolivia	0– 4000	Open country	Feb.-Jun.	Same	Very different	Moderately different

nest records were available for the species; in others, scores of nests had been found. Whenever the breeding season as given is very short, covering only a month or two, it is based on a small number of nests; and it is probable that a greater number of records would show a considerably wider spread of dates. It is important to emphasize that imperfect though our information is, it is sufficient to prove that in no known instance do the congeneric species of birds that nest in the same area in Central America have breeding seasons that are mutually exclusive. On the contrary, wherever there are sufficient records of nests, they show that the breeding seasons of the two species are very much the same, although one may nest over a period a month or two longer than the other.

One of the forms of physiological isolation most easily discovered is that resulting from mutually exclusive breeding seasons; if two species are not in the reproductive state at the same time, obviously they cannot interbreed, although they live side by side. This condition is sometimes found among plants, although more commonly all the congeneric species of the same region flower at the same season, as violets (*Viola*) nearly all blossom in the spring, and golden-rods (*Solidago*) in the late summer and autumn. But I am aware of no instance of congeneric species of birds that nest at quite different periods. So far as their nesting seasons are concerned, any of the species bracketed together in the table could interbreed and hybridize. Yet hybrids between these species appear never to have been discovered; and in my experience with Central American birds, I have never found individuals of two species even trying to mate together. When two closely related species build nests of the same form, in the same tree, and at the same time, how is it that they never interbreed? In the last three columns, I have attempted to analyze the factors which keep them separate.

Appearance.—Some of these congeneric species are so different in appearance that no observant person, be he ornithologist or not, could possibly confuse them. This is true of the two species of *Myrmotherula, Todirostrum, Pipra* and *Thryothorus,* of the two sets of species of *Thraupis,* and of all five of the species of *Calospiza.* At the other extreme, a few of our congeneric species are so closely similar that, in regions where they occur together, even the experienced bird watcher must exercise great caution in his field identifications—especially if he depend upon appearance alone for their recognition. Among the ground doves, *Columbigallina talpacoti* and *C. minuta* are confusingly alike. So long as the Northern Elaenia (*E. flavogaster*) keeps its crest laid flat, it may readily be confused with the other two gray species with which it lives; but when raised, its higher crest, white in the center, is a good recognition mark. So, too, the species of *Myiobius* are of similar aspect. The males of all three species of euphonias (*Tanagra*) listed in our table are much alike in appearance; those of *T. luteicapilla* and *T. imitans* are confusingly alike even after long familiarity with them. The females of these two species are far more readily separated. I frequently see both of these euphonias in the trees about my house; and *T. luteicapilla* sometimes nests here; but the only nest of *T. imitans* that I have found was in the neighboring forest.

Among the flycatchers of the genus *Myiozetetes, similis* and *granadensis* are similar in size and general aspect, both being olivaceous above and bright yellow below; but they are easily distinguished by their head markings, *similis* having a dark forehead and white superciliary stripes, *granadensis* a white forehead but no superciliary bands. These two species build oven-shaped nests which I cannot distinguish, one pair of each frequently nesting in the same small tree. This past season, two orange trees and a lemon tree close by my house each contained a nest of *similis* and one of *granadensis,* separated by only a few yards; all four nests in the orange trees were successful. I have never found in the same tree two nests of *similis,* nor two of *granadensis.* Yet the terri-

torial instinct is only weakly developed in these birds, for two nests of the same species will often be found not far apart, with indistinct boundaries between the domains of the two pairs; one often trespasses upon the other's land without being chased. *Myiozetetes similis* and *cayanensis* are so very similar that only the sharpest eyes can distinguish them in the field. Yet once, in Panamá, I found nests of both in the same small orange tree.

Voice.—The species that are so similar in plumage are readily distinguished by their voices. The quite distinctive call notes of *Myiozetetes similis* and *M. cayanensis* furnish by far the simplest means of field identification; while *similis* and *granadensis* may be distinguished by their voices at a greater distance than is possible with good field glasses. So, too, the three species of *Elaenia* are more easily distinguished by the ear than by the eye; and this is true to a high degree of the two euphonias, *Tanagra imitans* and *T. lutcicapilla*. In fact, all these congeneric species that nest together are quite easily distinguished by their voices, save possibly in the few instances where I have left blanks in the ninth column, for I have not heard one member of the pair for many years, and finding no explicit statements on this point in my notes, I think it safest not to lean too strongly upon memory.

The longer my period of association with the birds of any region, the less I depend upon field glasses and the more I rely upon my ears for the recognition of those I meet from day to day. Since birds have acute hearing and make frequent use of their voices in keeping in touch with their mates or companions, we may be sure that voice plays a most important part in their recognition of each other. Whether this part is more important than that taken by sight I hesitate to say, but in many instances I suspect that it is.

How well birds can recognize each other as individuals may be illustrated by an observation that I made some years ago, while I dwelt in the valley of the Río Pacuar, near the western end of the Basin of El General in southern Costa Rica. In a neighboring pasture was a flock of three Smooth-billed Anis (*Crotophaga ani*) and a lone Groove-billed Ani (*C. sulcirostris*). The first species is very rare in Costa Rica; there is, I believe, only one published record (quoted in Bent, 1940); and these three individuals, with one other soon to be mentioned, are the only ones I had at that time seen in the country. The Groove-billed Ani, although generally abundant in cleared districts at lower elevations throughout the length and breadth of Central America, is for some unexplained reason rather rare in El General. The lone bird in the pasture had no close neighbors of its kind. In another pasture higher up the mountain there was a small flock of Groove-billed Anis; but an intervening belt of high forest served as an effective barrier between these birds which avoid the heavy woodland.

Few birds are more sociably inclined than the anis which build communal nests in which several females lay their eggs in a common heap, all the cooperating members, both male and female, taking turns at incubating them, and all joining in nourishing the young. The lone Groove-billed Ani in the pasture, finding itself somehow separated from all others of its own kind, attempted to satisfy its thwarted social instincts by attaching itself to the flock of three Smooth-bills. These two species resemble each other so closely that only by examining their bills through field glasses at close range, and under the most favorable conditions of lighting, could I distinguish them visually; but their distinctive calls at once betrayed their separate identity. Again and again, day after day, the soft-voiced Groove-bill attempted to join the trio of louder-voiced Smooth-bills, only to be rebuffed and chased away by one or another of them. In the evening, it would try to enter the little clump of bushes in the midst of the pasture where the Smooth-bills

roosted; but one would issue forth and chase it away; and this would be repeated until the light had grown dim and the poor Groove-bill was obliged to go off and spend the night alone. For well over a month, the Groove-billed Ani hovered about the three Smooth-bills and was driven off by them innumerable times. Since it so greatly resembled them in outward aspect, it might be suspected that it was treated as a foreigner only because it spoke a strange language and that if it had learned to silence the soft *ti-ho* which it repeated almost every time it flew, it might have succeeded in attaching itself to the only others of its genus in sight.

However, this explanation is not necessarily correct. It is well known that anis can recognize members of their own flock by sight (see Davis, 1940); in fact, a fourth Smooth-bill, that from time to time appeared and wished to join the three, was chased away exactly like the lone Groove-bill.

These two species of *Crotophaga* in general occupy complementary parts of the vast extent of the American tropics; but they are found together in Panamá and along the west coast of South America as far as Ecuador, where I have seen both in the same neighborhood. Without much doubt they at times nest not far apart; but I have no actual record of this.

Voice is of the greatest aid to the field ornithologist in distinguishing closely similar races, species, and even genera of birds, and its probable rôle in the differentiation of species has never received the attention it merits. Especially among the American flycatchers (Tyrannidae) it appears to be of importance, not only among the small grayish species that so greatly try the patience of ornithologists, but even among the big kinds clad in bright and contrasting colors. The two largest flycatchers of Central America, the Kiskadee (*Pitangus sulphuratus*) and the Boat-billed Flycatcher (*Megarhynchus pitangua*), both wide-ranging, common species often found in the same district, are, despite their generic distinctness, sufficiently alike in appearance to confuse the beginner —and they are by no means plainly colored birds, but are dressed in a boldly variegated pattern. This color-pattern is amazingly similar to that of the two species of a third genus, *Myiozetetes*, which we have already noticed as being so confusingly alike in appearance; these are, however, considerably smaller than *Pitangus* and *Megarhynchus*. A bird of yet a fourth genus, *Myiodynastes chrysocephalus*, so closely resembles *Myiozetetes similis*, that when I first entered the highland region where this rare bird dwells, I confused it with the latter until its sharper notes drew my attention to its distinctness. All these species are easily known by their very distinct voices. So, too, the two races of *Myiozetetes similis* inhabiting Central America are in the field more readily distinguished by voice than by any other means. The southern race, *columbianus*, singing at dawn during the breeding season in April and May, repeats over and over the phrase *chips-â-cheery*, very clearly enunciated. The northern race, *texensis*, uses at best a garbled and scarcely recognizable version of the same phrase.

It would be easy to extend the list of closely allied birds that are more readily distinguished in the field by voice than by appearance. Another excellent example is furnished by two congeneric woodhewers: *Lepidocolaptes souleyetii* of the lowlands utters a beautiful, clear trill; *L. affinis*, its highland counterpart, has a weak, sad trill. Saunders (1929) concluded from studies of the voices of North American birds that "no two species of the same genus, breeding in the same area, have songs that are just alike." But when closely related species occupy different breeding ranges, there often are few or no definite differences in their songs. To the examples he gives in support of this last statement, I might add that of two pigeons which replace each other altitudinally in Central America, *Columba nigrirostris* of the lowlands is not only confusingly similar

in appearance to its highland representative, *C. subvinacea,* but I can not with certainty distinguish their melodious, far-carrying calls. Perhaps every widely travelled bird watcher has had the experience, when visiting a new region, of hearing an old familiar bird voice which he at first supposes to belong to a species well known to him, only to find, upon tracing the sound to its source, that it is the utterance of some related bird. Under these circumstances, it is the close resemblance of the songs of the two species that seems important. Since a considerable interval of time often separates our hearing the songs of the two kinds of birds, differences are apt to be forgotten or overlooked. Could we hear them both within an hour, I believe that we should far more often detect differences in the voices of these closely related allopatric species.

Among the resident birds of the tropics, the method of pair formation is even more difficult to discover than in the migratory birds of higher latitudes. Because many males of migratory species, upon arriving in the spring, take up territory, isolate themselves, and make themselves conspicuous before the arrival of the females, their behavior at this critical period is relatively easy to follow. But tropical birds as a rule pair long before the beginning of the nesting season, sometimes while living in flocks, more often in seclusion or while roaming among the tree-tops. At least a third of the species listed in the table are seen by twos at all seasons and probably pair for life; many of these birds appear to choose their mates at an early age, and by processes difficult to fathom. But whatever the method of pair formation, we may be sure that recognition of the potential partner as to species and as to sex is an essential part of it; and it is reasonably certain that with most birds this recognition is effected through both the eye and the ear.

On the other hand, among the hummingbirds, manakins, and flycatchers of several genera, including *Myiobius,* no lasting bonds are formed between the sexes, and the male takes no share in the activities of the nest, not even guarding it. The flycatchers of the genus *Myiobius* are rather silent birds but display by spreading their black tails, drooping their short wings, and exposing their bright yellow rumps as they flt among the boughs. Male hummingbirds of many kinds, including *Phaethornis,* are found in the same spot day after day during a long breeding season, tirelessly repeating a little "song," in some species the mere repetition of monotonous, squeaky notes, in others a charming musical performance. While calling in these courtship assemblies, the hummingbirds display little or not at all; the hermit hummingbirds of the genus *Phaethornis* merely wag mechanically a long, white-tipped tail. Male manakins likewise center their activities around certain definite posts, where they call tirelessly; and in some species the males "dance" and indulge in the most bizarre antics, by means of which their often striking peculiarities of plumage are displayed for the benefit of the other sex. In this family, voice and color-pattern may vary so greatly even among species of the same genus that it is almost inconceivable that the female of one species should be attracted by the male of another.

While studying the White-eared Hummingbird (*Hylocharis leucotis*) in the Guatemalan highlands, I found amazing differences between the "songs" which different males repeated tirelessly during the breeding season. Frequently, after laboriously tracing a strange bird note to its source, I was surprised and somewhat vexed to find it just another White-eared Hummingbird. The male hummingbirds usually gathered to sing in little groups of from two to seven individuals; and those in the same assemblage as a rule used a rather similar "song," often strikingly distinct from that in vogue among a neighboring group. It was impossible to decide whether these differences in voice were genetic or merely arose from the fact that the birds in any assemblage imitated one individual who perhaps had been there first or was somehow dominant. If one of these hum-

mingbirds had joined another group that sang a very different tune, one wonders whether it would have been capable of following the fashion there prevailing. The variation among the voices of the White-eared Hummingbirds was so great that I at first inclined to the belief that it might be caused by differences in the structure of the vocal organs, which in turn were of genetic origin. However, if one thinks of the variety of sounds produced by a single flicker, starling, chat, or song sparrow, or of the ease with which certain captive birds adopt new songs, this hypothesis loses much of its attractiveness. The lack of a genetic basis for these differences of song would invalidate any idea that these song populations might be incipient species. For a reference to the genetic difficulties involved in any hypothesis of sympatric speciation, see Mayr (1942:204). It would be very difficult to imagine a mechanism that would produce males homozygous for a specific song type and simultaneously females equally homozygous in their exclusive preference for males of this kind of song. All these difficulties are removed if it is assumed that both the new song as well as the preference for it were developed during geographical isolation.

I believe that variations in voice, which are generally neglected, may be of no less importance as starting points in the evolution of new forms of birds than those slight differences in size and color that now receive such painstaking study and minute description. In the past it was not possible to preserve the notes of birds for future objective study and to make direct comparisons between species or races with diverse ranges, as has long been done with their skins. It is to be hoped that the recently developed art of recording bird voices will soon be perfected to the point where it will be called into service by students of taxonomy and geographic variation. Perhaps, before many years have passed, our handbooks of birds will be accompanied by phonographic records reproducing the songs and calls of each species. If this happy day arrives, such groups as the small, plainly clad flycatchers, now the despair of the field ornithologist, should present no greater difficulties in identification, to one with a moderately good ear, than the multihued tanagers to one who is not color-blind.

We must admit our complete ignorance of whether any of the pairs of congeneric species that have occupied our attention are prevented from interbreeding by sterility barriers. So far as we know, no two of these species have attempted to interbreed. But in view of the cross-fertility of numerous other species of birds that have been bred in captivity, it is fair to suppose that some at least of those we consider here could be successfully crossed under the conditions of the aviary. In nature, however, there seems rarely to be need of a sterility barrier to prevent the blending of related species of birds that occupy the same area. In all but a few exceptional cases, as the well-known hybridization of the Golden-winged Warbler (*Vermivora chrysoptera*) and the Blue-winged Warbler (*V. pinus*), another, subjective, factor prevents their even attempting to interbreed. We might call this for brevity "psychological isolation," and it appears to operate chiefly through differences in plumage and voice.

Habitat preferences.—A third way in which subjective factors may operate in keeping congeneric species distinct is through habitat preferences. Moreau (1935), after a detailed analysis of the local distribution of birds in an area of tropical Africa, could in many instances find no physical or biological differences between contiguous habitats that seemed adequate to explain the well known restriction of so many tropical birds to definite and often narrow altitudinal belts, or slightly differing vegetational formations. With apparent reluctance, he concluded his patient study with this statement: "Much of the Usambara distribution appears to be explicable only by subjective factors." Similarly, here in Costa Rica, many facts in the local distribution of birds appear

inexplicable except on the hypothesis of purely subjective preferences of certain species for certain surroundings—preferences which seem in some instances to be understandable from a consideration of the ancestral history of the birds in question. We shall limit ourselves to two examples among the local birds.

Why should the wren *Thryothorus nigricapillus semibadius* remain so closely attached to the courses of the wider streams, although it appears to derive no nourishment from the rivers themselves, but forages among the marginal bushes and vine tangles in exactly the manner of many another wren that ranges through thickets at a greater distance from running water? The only explanation that has occurred to me is that for many generations before the recent human settlement and extensive clearing of land in this region, the type of vegetation which it prefers was hardly to be found except along the banks of the broader streams. Although human activities have resulted in the creation of rather similar vegetation elsewhere, as in the vine tangles at the edge of the forest where it borders pastures and other clearings, where these birds could without doubt find adequate concealment and almost with certainty a sufficiency of the proper kind of food, the Riverside Bay Wrens remain close to their ancestral haunts because they do not "feel at home" at a distance from them.

The two doves of the genus *Leptotila* inhabiting this region are so similar in coloration that they can be distinguished only by careful scrutiny. The Verreaux White-fronted Dove (*L. v. verreauxi*) forages over shady lawns and close-cropped pastures, as well as beneath somewhat open thickets. The Rufous-naped Cassin Dove (*L. cassinii rufinucha*) hunts beneath these same thickets and others heavier, where the White-fronted Dove is not found; but it usually avoids the lawns and pastures. Yet it is hard to believe that one of these brownish pigeons should shun the open spaces because it would be a more conspicuous mark for birds of prey than the other, expecially in this region where bird-eating hawks are rare; and the food that one finds in the pasture would certainly seem to be good nourishment for its congener. The White-fronted Dove is a far-ranging species that probably grew accustomed to open country in regions that have been long shorn of their forest covering; the Cassin Dove is a species of restricted range that has not yet learned to take advantage of the recently made pastures.

SUMMARY

Twenty-nine pairs of congeneric species of birds, one group of three species, and one group of four, have been found nesting in the same or in contiguous areas during fourteen seasons of field work in Central America. An attempt is made to discover what prevents the interbreeding of these closely related species that come in contact during the nesting season. In no instance do the congeneric species have mutually exclusive breeding seasons; hence it is not possible that interbreeding is prevented by the circumstance that they do not enter the reproductive state at the same time. Some of these congeneric species may be distinguished at a glance, whereas others are confusingly similar in appearance; but nearly all are readily recognized by their distinctive voices. It is not known whether any of these congeneric pairs are physically able to produce hybrids; but for these species to remain distinct, sterility barriers do not appear to be necessary, because subjective or psychological factors seem to keep them from intermating. This "psychological isolation" appears to operate chiefly through differences in plumage and voice, but also through divergent habitat restrictions, some of which at least seem to be based upon subjective preferences rather than upon the physical or biological unsuitability of neighboring habitats from which the species is absent.

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BIRDS AND AN ANT ARMY IN SOUTHERN TAMAULIPAS

By GEORGE MIKSCH SUTTON

In midafternoon on March 19, 1949, in thick scrubby woodland along the Río Sabinas, near the hill village of Gomez Farias, in southwestern Tamaulipas, I was afforded a remarkable and wholly unexpected opportunity to observe certain Mexican birds which I had many times heard but never very satisfactorily seen. Chief among these were the Barred Ant Shrike (*Thamnophilus doliatus*) and the Red-throated Ant Tanager (*Habia gutturalis*), forms which reach their northernmost limit of range in or near that area.

I had devoted that day almost exclusively to hunting Groove-billed Anis (*Crotophaga sulcirostris*), a species well known and common thereabouts, but unaccountably hard to find at the moment. My Mexican friends called these birds *garrapateros*—tick-birds. The matter was urgent, for this was to be my last full day in the low country along the Sabinas and several specimens were needed. Midafternoon was not, admittedly, a good time for bird hunting, but I reasoned that if I found the anis at all they would probably be sitting quietly in the shade and easy to obtain.

Bearing in mind that I had often seen anis near livestock, I visited all the places at which I knew cattle would be resting at that time of day. But not a single ani did I see or hear. Refusing to give up, I decided to concentrate upon the place at which I had shot a specimen that morning. There, I recalled, the bird had flown southward from a clearing into the shrubbery, and I had heard another calling farther to the southward in the thicket. This was not a comforting thought. It was tick season and I knew the young ticks, the dread *pinolillos*, would be especially numerous in the dense, tangled mats of wild pineapple. Following a straight, little-used trail along a fence, I eventually came to a freshly cut property line leading south. The air was soft and hot. I could see tiny ticks crawling up my pants. Some of these I brushed off vigorously. How shut-in and apart from the rest of the world the thicket seemed!

Suddenly, some rods off in the tangle, I heard a most welcome sound, the clear-cut *pee-to* of an ani. I started straight through the thicket, but quickly changed my plan partly because of the thorny vines and partly because I heard another ani calling nearer at hand and in a different direction. Returning to the property line and following it, I presently saw three anis fly up, then a fourth. The last was the closest of all. It did not seem shy and I had little trouble approaching it. As I shot, the other three flew off, disappearing to the northward. I retraced my way along the property line, pausing frequently to listen. When fifty yards or so from the place at which I had shot the bird, I was surprised to hear a sharp *pee-to* very near me and to see five or six anis hopping and flying southward through the thicket. Confident that I should be able to obtain more specimens if only I could keep track of the flock, I started after them. All at once anis seemed to be all about me, hopping through the shrubbery and calling excitedly. Soon I had my six specimens and needed no more.

The living anis, instead of flying off as I had expected them to, continued to stay close by, and their behavior puzzled me greatly. At first I thought they were merely curious. Then, watching them closely as I held one of the specimens toward them, I fancied reading suspicion and resentment in their behavior. I could not remember ever having seen wild, free-flying anis at such close range.

The sensations of the next few seconds were so vivid, so wholly unexpected, and followed each other in such rapid succession, that they were—and I use the word realizing that it hints of hyperbole—semiparalyzing. I stood there as if transfixed, as if

actually unable to move, appalled by the enterprise of which I seemed suddenly to have become a part. Birds of many sorts were all about me, among them species I had spent hours looking for and never before so clearly seen. Some of the least familiar were almost within touching distance. They were feeding eagerly, almost gluttonously, it seemed, on insects which continued to rise from the ground and undergrowth. Without having either the time or the ability to identify these insects very satisfactorily, I saw moths, leaf-hoppers, stink-bugs, grasshoppers, crane flies, and beetles, not to mention unwinged forms which were moving, apparently in all possible haste, up, up, up the twigs and leaves. The flying insects poured out so incessantly that I could not help thinking of a barrage in miniature, or odd little fireworks in display. All these insects were—and the full impact of the idea was terrific—fleeing for their lives. The birds were eating them, to be sure, but it was not really the birds they were fleeing from. Their true enemies were ants—an ant army.

The ants, thousands upon thousands of them, were moving in a mass directly toward the trail in which I stood. I could see the vanguard filing slowly but inexorably forward in lines along certain twigs and grass blades only a rod or so away. Those which were obliged to move over the dead leaves on the ground were impeded by the uneven surfaces. The vanguard did not seem to be putting any insects to flight. But just to the rear of them, back where the shadowed, sheltered spots were being invaded, the activity was intense. I saw a large caterpillar at the end of a twig turn and twist violently as the ants bit it. In its writhing it lost its grip and fell to the ground. I saw a fritillary butterfly flapping its wings as if for flight and then I watched the four wings separate, move off in different directions, fall flat, and completely disappear beneath the ants. The noise of the approaching army and of the fleeing insects was incredible. Not that this sound was loud. At first I did not notice it, or if I did, I attributed it to wind in the tree tops. It was a seething sound. I had heard something like it at the mouth of Tornillo Creek, along the Rio Grande, when water from a cloudburst far upstream had suddenly filled the broad gravel bed and risen swiftly.

The ant army's front seemed to be twenty or thirty yards broad. This I guessed from the concentration of fleeing insects and of the birds which were capturing them. The ants stayed close to the ground. I saw them on fallen branches, on shrubbery, and on the roots and lower trunks of the trees, but they did not seem to be moving up into the higher branches.

After a moment I walked swiftly to one side, following that blessed property line, surveyed the advancing army with the binoculars, decided that there could be no real danger so long as I was sound of limb, and retraced my steps cautiously. Especially noticeable were the very birds I had so wanted to see—the ant shrikes and ant tanagers. It was unbelievable that they should be moving about in plain sight, perching *on*, rather than *in*, the shrubbery. I had spent hours, literally hours, crawling about through bamboo tangles and tick-infested brush trying to see these birds and had usually failed miserably. Here they were, at least four ant shrikes and a company of eight or ten ant tanagers, each battering an insect to death, or swallowing hard, or wiping its bill energetically while getting ready for the next mouthful. The ant shrikes often lifted their crests high and the whiteness of their eyes was almost startling. Their legs and feet seemed disproportionately coarse. I did not see them alight on the ground, though they may have done so. They hopped vigorously from twig to twig, often without lifting or spreading their wings in the slightest. They did not, however, climb about as did the one Pepper Shrike (*Cyclarhis gujanensis*) of the flock. The ant tanagers, to my surprise, seemed to be too busy for scolding. In that very thicket I had often heard their rough

chatter and bursts of rich, full-throated song, but how very little I had seen of them! Here they hopped and fluttered about like dooryard birds, with body-plumage fluffed out slightly and wings and tails partly spread.

There was a flash of red-brown as a woodhewer (*Xiphorhynchus flavigaster*) flew in front of me, alighted on a trunk, hitched downward, dropped to the ground, and seized a large pale green orthopteran in its beak. With my glass I could see hundreds of ants moving about the woodhewer, but they did not seem to attack it. There was another flash of red-brown as a Squirrel Cuckoo (*Piaya cayana*) snatched at an insect and hopped rapidly off through the undergrowth. The birds were so active that it was hard to be sure how many there were of a given species. I believe, however, that there were four woodhewers and two Squirrel Cuckoos in the company. I saw neither Yellow-billed Cuckoos (*Coccyzus americanus*) nor Mangrove Cuckoos (*C. minor*), although both those species nested in the vicinity.

Small birds to which I had at first paid little attention were the dainty Fan-tailed Warblers (*Euthlypis lachrymosa*), Lichtenstein Warblers (*Basileuterus culicivorus brasherii*), White-eyed Vireos (*Vireo griseus*), Yellow-green Vireos (*Vireo olivaceus flavoviridis*), White-bellied Wrens (*Nannorchilus leucogaster*), Spotted-breasted Wrens (*Thryothorus maculipectus*), and Olive Sparrows (*Arremonops rufivirgatus*). There were several of each of these, but I saw no Pitiayumi Warbler (*Parula pitiayumi*), no gnatcatcher, and no hummingbird of any sort.

I made a point of noting that no black bird which put in its appearance was of a species I had long been wanting to see to better advantage, the Prevost Cacique (*Amblycercus holosericeus*). Nowhere, indeed, did I see an icterid of any sort, although several species of that family lived thereabouts. In the wake of the army, rather than in the midst of it or in front of it, were several Green Jays (*Xanthoura yncas*), a few Gray Robins (*Turdus grayi*), two or three Long-billed Thrashers (*Toxostoma longirostre*), and at least one Blue Bunting (*Cyanocompsa parellina*). In the trees not far from the ants, but definitely above ground, were two pairs of Rose-throated Becards (*Platypsaris aglaiae*), a single Olivaceous Flycatcher (*Myiarchus tuberculifer lawrenceii*), and two Ladder-backed Woodpeckers (*Dendrocopos scalaris*). The more I thought about the matter, the more puzzled I was at seeing no Brown Jays (*Psilorhinus morio*), Crimson-collared Grosbeaks (*Rhodothraupis celaeno*), Black-headed Saltators (*Saltator atriceps*), or large flycatchers of the genera *Tyrannus, Myiodynastes, Pitangus* and *Megarynchus*. My failure to see any little stub-tailed euphonias of the genus *Tanagra* did not surprise me, for I knew that those tanagers subsisted principally on mistletoe berries. I was not surprised at seeing no doves or pigeons, and swallows and swifts would have seemed entirely out of place in the thick woods. It is noteworthy that I saw no Blue-crowned Mot-mot (*Momotus momota coeruliceps*), Pygmy Owl (*Glaucidium brasilianum*), or Coppery-tailed Trogon (*Trogon elegans ambiguus*), and no crypturiform, falconiform, or galliform bird of any sort.

I did not collect specimens of the ants but suspect they were of a species which ranges little, if any, farther north than the Sabinas valley. The army was so dense that it almost hid the ground in spots, but it did not move forward very rapidly. I did not see a bird of any sort feeding directly on the ants themselves, nor did I see an ant attack any bird. I saw nothing which called to mind the phenomenon of "anting." Somewhat to my surprise I saw no snakes, tarantulas, scorpions, centipedes, or small mammals which had been put to flight. The two or three lizards which I saw in the vicinity may have been attracted, as had the birds, by the fleeing insects.

University of Michigan Museum of Zoology, Ann Arbor, Michigan, August 30, 1950.

A COOLING MECHANISM OF THE TEXAS NIGHTHAWK

By RAYMOND B. COWLES and WILLIAM R. DAWSON

The maintenance of body temperatures within the often very narrow limits permitting normal metabolic rates is one of the foremost problems faced by terrestrial organisms. In the vertebrates, both the ectothermal cold bloods and also the warm-blooded, endothermic birds and mammals, thermoregulation often is so important that many species have augmented their intricate physiological adaptations with others involving behavior.

The present discussion is concerned with an adaptation of the Texas Nighthawk, *Chordeiles acutipennis texensis*, for maintaining a proper body temperature in spite of the extreme environmental heat to which it is exposed during the daytime throughout the greater part of its summer range. This species commonly breeds in the Lower Sonoran Zone of the southwestern United States. The majority of the nesting activity of these birds takes place in June when the temperatures on the desert are approaching their maximum, which on the surface in full sun frequently ranges upward of 50° or 60°C. The eggs are incubated in the open, on the ground, where the heat would rapidly kill the embryos; therefore, the adult birds must shield them and while doing so they must remain in the open, exposed to the full daytime temperatures which prevail throughout the nesting season. Because of this, it seems probable that their problems in matters of temperature-control would be greater than those of other desert birds which may resort to shade during the heat of the day. On logical grounds it would not seem unwarranted to conclude that this species must possess some positive adaptation to withstand the severe temperatures described. To discover what this might be, the study here reported was undertaken.

Methods.—The most difficult problem was that of procurement of live individuals for purposes of observation and experiment. Because the nighthawks feed exclusively while in flight, the use of traps seemed precluded, and their wide dispersal in desert areas and their inconspicuousness while resting on the ground made them practically unobtainable by any ordinary procedures. It was therefore necessary to attempt their capture by shooting them while they were in flight. In order to reduce killing to a minimum, the birds were shot at long ranges. The more severely wounded were immediately sacrificed after temperature records were taken, and these and the occasional killed birds were then skinned in order to obtain the figures given below for the ratio of mouth to body surface. Birds that were only slightly wounded were used in experiments from which were derived the majority of the data presented here. When a wounded individual was procured, it was placed in the sun where its body temperature was recorded at intervals and its actions observed.

Results.—The most striking behavior was observed when the nighthawks were exposed to the sun. At first they remained quiet, but as body temperatures increased, they would open their mouths. Soon after this the gular areas would be fluttered rapidly. If the day was hot enough, this procedure was invariably followed and the action was interpreted as being a means of heat dissipation in a manner analogous to panting. In order to test this analogy it was necessary to examine critically the action of the mouths of the nighthawks under varying conditions.

Like that of other species of caprimulgids, the gape of the nighthawk is a conspicuous feature of its anatomy. Although this has always been considered an adaptation for aerial feeding, it is also clear that every time the mouth is opened a considerable area of moist surface is exposed. The observed expansion and fluttering of the gular area

would appear to facilitate evaporation from this surface. Thus morphologically the mouth area would seem to be an ideal cooling mechanism. Associated with the extent of the mouth area it was also noted that there was a considerable change in the vaso-dilatation in this area and this appeared to be correlated with gross temperature changes. The mouth is well supplied with blood vessels, both on the roof and floor, and following vaso-dilatation the high degree of vascularity is readily perceived.

The accompanying table shows the various temperature records obtained in the course of this investigation. In all but a few cases both cloacal and oral temperatures were taken. The recorded differences are notable in certain instances. Quite possibly the relative humidity and temperature of the air at the time the records were obtained are responsible for the wide variations in the amount of difference.

Air temperature	Cloacal temperature	Oral temperature	Degrees difference	Morning or evening flight
40.4° C.	43.6° C.	35.0° C.	8.6° C.	P.M.
40.4° C.	41.6° C.	.....	.....	P.M.
38.0° C.	41.2° C.	38.0° C.	3.2° C.	P.M.
37.0° C.	42.2° C.	38.5° C.	3.7° C.	P.M.
17.4° C.	41.0° C.	30.0° C.	11.0° C.	A.M.
34.0° C.	40.0° C.	38.0° C.	2.0° C.	P.M.
32.0° C.	40.2° C.	36.0° C.	4.2° C.	A.M.
32.0° C.	41.0° C.	39.0° C.	2.0° C.	A.M.
32.0° C.	41.9° C.	38.0° C.	3.9° C.	A.M.
20.0° C.	42.0° C.	27.0° C.	15.0° C.	A.M.
20.0° C.	41.0° C.	.....	.....	A.M.

In every instance it was noted that the oral temperature was lower than that of the cloaca. As will be noted from the table, the differences range in value from 2°C. to 15°C.

To illustrate the importance of this temperature difference in thermoregulation during the heat of the day, and probably in periods of intense activity, the ratio of the area of the bird's oral to its total body surface was computed. These ratios were obtained by skinning the bird and computing the area of the skin, then comparing this with the area of the oral surfaces. The value for this ratio was approximately 15 per cent. It is probable that the estimated value of 15 per cent is conservative, owing to the unavoidable stretching of the skin while being removed from the body. The ratio of areas was determined by tracing on graph paper and the number of squares included in each tracing computed, thus yielding the values from which this ratio was derived. The fact that the moist oral surfaces of the nighthawk represent so large an area, well supplied with blood vessels and capable of being fluttered on occasion, is suggestive of their function in the control of body temperatures.

In order to obtain quickly a sufficiently high environmental temperature, the first nighthawk was placed in a one-quart jar. A quick-registering mercury thermometer was used in order to record the cloacal temperatures. From an initial body temperature of 40.5°C., that of the bird four hours after its early morning capture, the temperature increased until, eleven minutes later, it became constant at 42.9°C. Two minutes prior to reaching this level, the bird had started to flutter its gular area; and between 21 and 24 minutes after inception of the experiment, the cloacal temperatures began to decline. The environmental temperatures within the jar dropped rapidly from 44°C., and thereafter throughout the rest of the experiment the temperatures ranged between 42° and 40°C. Condensation of water on the surfaces of the jar indicated a high relative humidity. The bird was removed from the jar, for photographic purposes, and thereafter all experiments were conducted in the open in full sunlight.

In rather sharp contrast to the results obtained with the first bird are those procured from a second one which was not placed in a jar. This bird's temperature did not go as high as the former's and was reduced more rapidly. During the observation it was placed on some light-colored sand, the temperature of which was 50°C. This temperature was hotter than that of the jar at the beginning of the first experiment.

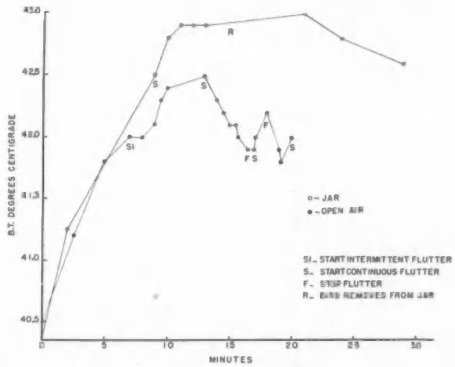

Fig. 1. Graph showing effect of gular fluttering on cloacal temperature of two Texas Nighthawks kept in sun, one for part of time in glass jar. Zero minutes is time at which birds were placed in sun.

The bird began to flutter its throat when its body temperature reached 42°C. This fluttering was intermittent and did not prevent a further rise to 42.5°C. At this point the throat was being fluttered continuously, and within a minute the body temperature began to decrease. When it had fallen to 41.9°, three and a half minutes later, the fluttering stopped. In approximately 30 seconds, pulsations were resumed. Within one minute the body temperature increased to 42.2°, and at this time fluttering ceased and almost simultaneously the temperature began to fall.

The difference in the temperature records obtained from these two birds probably can be explained on the basis of the difference in the humidity of the interior and the exterior of the jar. The respiration of the animal in the jar would increase the water content of the air inside and this would therefore tend to lessen the effectiveness of evaporative cooling. Further work is contemplated in an attempt to obtain temperature records, using some improved instruments.

In order further to determine the effectiveness of the gular fluttering as a cooling mechanism, the bill of the second bird was held closed, thus effectively stopping the fluttering of the gular region. At the end of 50 seconds the bird began to struggle and its bill was then released. During this time its temperature remained between 42.8° and 42.9°. Thirty seconds after release of the bill, the gular fluttering began and approximately 55 seconds later the body temperature began to decrease rapidly, leveling off 40 seconds later to 42.5°. One and a quarter minutes later the flutter momentarily ceased. At this time it was noted that the bird was facing into a mild breeze and that this was causing increased movement of the air within the mouth. The fluttering was resumed and continued until the body temperature had dropped to 42.2°, some six minutes after the bill had been released to permit gular cooling.

Discussion.—The amount of vascularity and the area of the oral surfaces of the nighthawk, coupled with the observations presented here concerning the effect of the gular flutter on the body temperature of this bird, form three lines of evidence which suggest the importance of this area in temperature control by this species. This, together with the insulating and reflective properties of its plumage are undoubtedly factors that enable it to remain in the full sun without need to resort to shade.

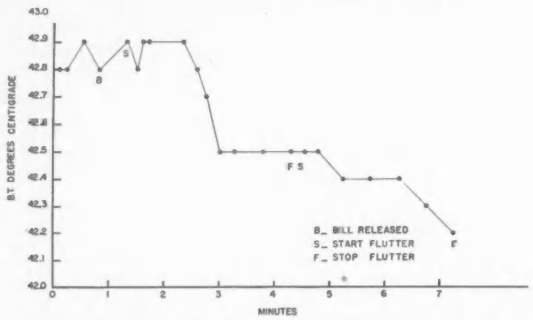

Fig. 2. Graph showing cloacal temperature of a nighthawk kept in the sun with bill held shut part of time to prevent gular fluttering. Zero minutes is time at which bill was closed.

That the nighthawk resorts to this evaporative cooling to withstand the extreme temperatures with which it is faced is not without complications. Temperature control of this nature means an extravagant amount of water loss in areas which are typically very arid. A question quite as important as temperature controls is how this species meets its water requirements

For the birds with which we were dealing this is comparatively easy. They avail themselves of water from the Colorado River. In the evening hundreds of them can be seen on the horizon, all flying toward this source of water. The flight toward the river may continue for almost an hour and a half, and it certainly represents movements of individuals from some distance away. For birds in other areas the answer may not be so simple, although there is the chance that they too may avail themselves of distant sources of water. However, if surface water is not accessible for considerable periods of time, they must survive on the moisture they obtain from their food, either directly or by means of metabolic water. The fact that insects are most abundant near sources of water may serve to restrict the nighthawk populations to near-by areas, thus indirectly limiting them to nesting sites within flying distance of water.

Since this cooling mechanism appears to be important in the ecology of this species, it would seem to offer a profitable line of investigation in this as well as in other caprimulgids, such as the Poor-will. A comparative study of *Chordeiles minor* would appear to be of particular value.

University of California, Los Angeles, California, July 24, 1950.

OSTEOLOGY OF COLINUS HIBBARDI, A PLIOCENE QUAIL

By HARRISON B. TORDOFF

The Pliocene quail species *Colinus hibbardi* was first made known by Alexander Wetmore. His description (1944:96) was based on two bone fragments, part of a right tarsometatarsus, which he designated as the type, and the distal end of a right humerus. These fragments were collected by Claude W. Hibbard, now at the University of Michigan, and his field assistants in 1937. Subsequent collecting by Hibbard, Richard Rinker, and Charles Carpenter in the summer of 1947 has made available approximately 170 additional bone fragments of birds of the same fauna—namely, the Rexroad fauna, Rexroad formation, Blancan age, of the Upper Pliocene of Meade County, Kansas. In identifiying specimens from this latter collection, I encountered 31 bones, mostly fragmentary, but a few complete, which seemed referable to this large Pliocene *Colinus*. Fortunately, the present collection includes both the elements which Wetmore described. The right tarsometatarsus herein figured is in better condition than the type. Dr. Wetmore personally examined eight fragments of the present collection which I identified as *Colinus hibbardi* and confirmed my determinations.

The Rexroad fauna is "now the most completely known fauna from a given horizon of the High Plains" (Hibbard and Riggs, 1949:859). Baker (1938), Hibbard (1941), and Franzen and Leonard (1947) have reported on the invertebrates. Taylor (1941; 1942) has described the herpetological material, while Hibbard (1941; 1950) and Hibbard and Riggs (1949) described the mammals. Wetmore (1944) has reported on the birds from "Localities 2 and 3," about 10 miles northeast of the locality of the present collection, taken in Meade County, Kansas, XI Ranch, NW¼ sec. 35, T. 34S., R. 30 W. (Fox Canyon). Wetmore speculated at some length on the probable environment of the Rexroad birds, but Dr. Hibbard tells me that the specimens described by Wetmore probably are from a pond or bog deposit, whereas the Fox Canyon deposits here reported on are apparently stream deposits.

In the course of identification of the specimens at hand, many forms have been found which were lacking in Wetmore's material. The relatively large number of quail bones (approximately 18 per cent of the total collection) and their excellent state of preservation made it seem worth while to devote special attention to a fairly detailed comparison of *Colinus hibbardi* with the modern Bob-white, *Colinus virginianus*.

To Dr. Hibbard I owe the largest debt of gratitude for his work in procuring the fossil material and in guiding me in the study of it. Dr. Wetmore's comments on the specimens that he examined for me have been helpful. George M. Sutton aided me in determining which measurements should be taken. Jane S. Mengel made the drawings here reproduced, and to her I owe my thanks.

Wetmore's allocation of this Pliocene quail to the genus *Colinus* seems unquestionably correct. Comparisons with genera of quail other than *Colinus* have been made here only to verify the allocation of the individual elements to *Colinus*, and not to bring out all the differences between the genus *Colinus* and the related genera.

The nomenclature of the bones used in this paper is that of Howard (1929). The modern Bob-white skeletons used for comparative material are in the University of Michigan Museum of Zoology. All are Michigan or Wisconsin specimens of *C. v. virginianus*. The fossils described are in the University of Michigan Museum of Paleontology (abbreviated UMMP below). The abbreviation KUMVP in table 7 refers to the University of Kansas Museum of Natural History (Vertebrate Paleontology).

ELEMENTS IDENTIFIED

Cervical vertebra.—One well preserved cervical vertebra (the sixth or seventh) I have identified as belonging to this species because of its resemblance to that of *C. virginianus* and because its size is slightly larger than the same element of a modern adult male Bob-white. Four other, fragmentary cervical vertebrae probably also are *C. hibbardi*. However, these elements often fail to supply any

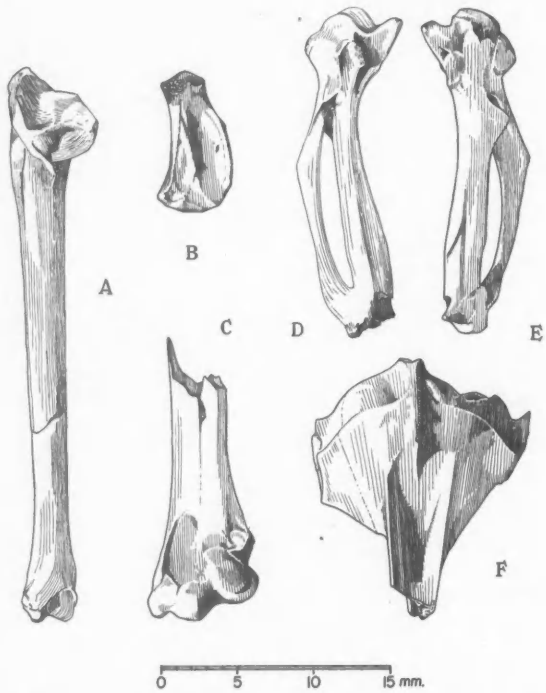

Fig. 1. *Colinus hibbardi*. A, left ulna, UMMP no. 24757. B, proximal phalanx, digit 2 of right manus, UMMP no. 26859. C, distal end of left humerus, UMMP no. 26850. D and E, left carpometacarpus, UMMP no 24753. F, anterior portion of sternum, UMMP no. 26840.

characters sufficiently diagnostic to separate even the modern quail genera (except where size is conclusive); thus, specific identifications based on these elements alone are hazardous. The five fossil vertebrae are grouped under UMMP no. 26842.

Sternum.—Three fragments of the anterior ends of sterna, UMMP nos. 26840 and 26841 (two bones), are referable to this species. Upon comparison with eight modern quail genera, these fragments prove to be larger than the corresponding parts of *Cyrtonyx, Callipepla, Lophortyx,* and *Colinus,* and approximately the same size as those of *Oreortyx, Dactylortyx,* and *Perdix*. The elements are smaller than in *Alectoris*. The three fragments are distinguishable from the sternum of each of the aforementioned genera except *Colinus* in the size and shape of the pair of depressions on the anterior internal side of the sternum, the degree of anterior extension and lateral divergence of the double

anterior carinal margin, and in the degree to which the origin of the crest of the ventral manubrial spine is produced posteriorly. That portion of the sternum which is preserved in two of the three fossils (no. 26841) is especially difficult to measure precisely because there are few definite points of reference preserved. However, in the better preserved third fragment (no. 26840, fig. 1F), the ventral lip of the coracoidal sulcus is intact. Table 1 shows the transverse distance between the well defined ends of this sulcus of the fossil to be distinctly larger than in the modern specimens at hand.

Table 1

Measurements of Sternum and Coracoid

Specimens	Breadth of ventral lip of coracoidal sulcus of sternum	Greatest breadth of proximal (sternal) end of coracoid	Breadth of sternal facet of coracoid
C. hibbardi			
UMMP no. 26840	13.4 mm.	.....	.....
" 26843 (right)	.....	11.3 mm.	7.5 mm.
C. virginianus			
8♀♀, 2♂♂			
Mean, with standard error	10.9 ± 0.2	8.8 ± 0.2	6.2 ± 0.1
Range	10.4 — 12.3	7.8 — 9.4	5.8 — 6.6
Standard deviation	0.5	0.5	0.3

Coracoid.—Six of the seven fragments of coracoids found of this species are from the distal (humeral) end, whereas the seventh is a well preserved proximal (sternal) end. Again the specimens resemble modern *C. virginianus*, except for their larger size. The measurements given in table 2 are those described and illustrated by Howard (1929:354-355) for coracoids of cranes (*Grus*).

No. 26843 is the proximal 16 mm. of a right coracoid (fig. 2H). The tip of the internal distal angle and the tip of the sterno-coracoidal process are both slightly abraded. Otherwise, the specimen is perfectly preserved. The ridge running down the ventral face of the shaft and swinging out toward the

Table 2

Measurements of Distal (Humeral) End of Coracoid

Specimens	Distance from glenoid facet to head, c-d*	Breadth from glenoid facet to procoracoid, e-f*	Depth posterior to furcular facet, g-h*
C. hibbardi			
UMMP. no. 26844 (right)	9.7 mm.	4.0 mm.	3.8 mm.
" 26845 (left)		4.4	3.7
" 26846 "	10.0	4.9	3.8
" 26847 "	9.1	3.7	3.4
" 26848 "	9.6	4.3	3.5
" 26849 "		4.0	3.4
Mean, with standard error		4.2 ± 0.2	3.6 ± 0.1
Standard deviation		0.4	0.2
C. virginianus			
8♀♀, 2♂♂			
Mean, with standard error	8.5 ± 0.1	3.9 ± 0.1	3.2 ± 0.1
Range	8.1 — 9.0	3.5 — 4.0	2.9 — 3.7
Standard deviation	0.3	0.2	0.3

* See Howard, 1929:354-355, fig. 55.

sterno-coracoidal process is less prominent and less sharply defined in the fossil than in modern *C. virginianus*. As table 1 shows, this specimen is considerably larger than the corresponding element of the modern species.

No. 26844 is the distal 15 mm. of a right coracoid (figs. 2F and 2G). It is well preserved and little worn. Its greater bulk is evident upon direct comparison with the coracoid of modern Bobwhites (see also table 2). In the fossil, the scapular facet and the procoracoid seem smaller in relation to the thickness of the shaft than in *C. virginianus*, although the fossil is actually larger in all dimensions.

No. 26845 is the distal 25 mm. of a left coracoid. The head of the bone is lacking, thus destroying the characters of the furcular facet and the coraco-humeral surface. The missing piece was perhaps 3 to 4 mm. long. Otherwise, the fossil is well preserved and little worn. This fragment includes the central part of the shaft, which is missing on the two terminal fragments illustrated. On the basis of this fragment, and no. 26843 (above), I would estimate the total length of the coracoid of *C. hibbardi* to be about 37 mm. The coracoids of six modern *C. virginianus* (three from males) average 29.1 (28.3-31.2) mm. in total length.

No. 26846. Distal end of a left coracoid (fragment 17 mm. long), slightly worn, with the brachial tuberosity broken off, agrees with the other fossils in other respects.

No. 26847. Same part as preceding (12.5 mm. long), tip only of brachial tuberosity worn off. Well preserved and little worn.

No. 26848. Same part as 26846 (10 mm. long), considerably worn on the distal articular surfaces.

No. 26849. Same as 26846 (10 mm. long), little worn, except for broken tip of furcular facet and brachial tuberosity.

Humerus.—The distal end of a left humerus, no. 26850, including the shaft up to a length of 18 mm., is in a very good state of preservation (fig. 1C). Except for the missing ectepicondyle and ectepicondylar prominence, the details of the distal articular surfaces are well preserved and little worn. In general, this bone is like that of *C. virginianus*. Wetmore (1944:97-98), describing the distal end of a right humerus of *hibbardi*, says that the fossil differs from modern Bob-whites in that it is slightly larger and that the "brachial depression is relatively larger, with the ridge bordering it longer, extending farther up the shaft." This is true also of no. 26850 (see table 3). A distinct difference in bulk is noticeable upon direct comparison with a series of modern *C. virginianus*. Table 3 also shows that the present fossil is wider across the trochleae than is any one of the 11 measured individuals of the Recent species. A further point of difference which is evident on direct comparison is the straighter (at the distal end, at least) and heavier shaft in the fossil species.

Table 3

Measurements of Humerus

Specimens	Breadth across distal trochleae	Distance from proximal edge of impression of brachialis anticus to distal end of internal condyle
C. hibbardi		
UMMP no. 26850 (left)	7.6 mm. actual (broken) 8.0 estimated, if intact	6.9 mm.
C. virginianus		
9 ♀♀, 2 ♂♂		
Mean, with standard error	7.1 ± 0.1	5.9 ± 0.1
Range	6.9 — 7.5	5.5 — 6.5
Standard deviation	0.2	0.3

In regard to breadth across the trochleae of the distal end of the humerus of these two species of *Colinus*, I should point out that Wetmore (1944:98), whose fossils have come, apparently, from individuals of about the same size as the specimen at hand, gives measurements for four specimens—two fossils, both 18 mm., and two modern birds, 16.7 and 17.1 mm. These measurements clearly are erroneous; that is, they are too large, as a glance at table 3 will show. The error seems to be 10 mm. in each case, and probably resulted from a misreading of the calipers. Wetmore's measurements, less 10 mm., can be compared with mine.

Ulna.—Two complete (nos. 24757 and 24758) and three fragmentary (nos. 26851, 26852, and 26853) ulnae are referable to this species (see fig. 1A). Each of the complete bones, both from the left side, has been broken into two pieces and repaired. In preparing table 4, the breadth of the distal end has been measured perpendicular to the longest diameter of the external condyle, to the tip of the internal carpal tuberosity. The breadth of the proximal articular face has been measured perpendicular to the longest diameter of the internal cotyla, across the external cotyla. As the measurements show, the fossils are approximately 5 mm. longer than are ulnae of modern *C. virginianus*. Proportionally, this size difference is evident also upon direct comparison with other dimensions. Also, the impression

of brachialis anticus is relatively deeper and more sharply outlined in the fossils. Otherwise, I find nothing to separate the fossil species from the modern Bob-white on the basis of the ulna.

Table 4

Measurements of Ulna

Specimens	Total length	Breadth of distal end	Breadth of proximal articular face
C. hibbardi			
UMMP no. 24757 (left)	37.4 mm.	4.2 mm.	4.8 mm.
" 24758 "	38.7	4.7	4.9
" 26851 "		4.5	
" 26852 (right)		4.8	
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	32.3 ± 0.3	4.1 ± 0.1	4.2 ± 0.1
Range	31.5 — 34.1	3.9 — 4.3	4.0 — 4.6
Standard deviation	0.9	0.2	0.2

Carpometacarpus.—One complete left carpometacarpus (figs. 1D and 1E) and fragments of six others are clearly gallinaceous, and differ from that of *C. virginianus* only in averaging slightly larger. Except for size (and there is overlap here in some measurements), I am unable to find any constant differences between the fossils and the *C. virginianus* carpometacarpi (see table 5).

No. 24753, from the left side, is complete except for a small piece, about 2.8 × 2.5 mm., broken from the anterior face of the distal end of the shaft of metacarpal II (figs. 1D and 1E).

No. 26855. Left side, proximal end intact, with about 8 mm. of metacarpal II (including intermetacarpal tuberosity) and 2.5 mm. of metacarpal III attached.

No. 26854. Left side, intact except for most of process of metacarpal I and most of shaft of metacarpal III.

Table 5

Measurements of Carpometacarpus

Specimens	Total length	Greatest breadth of proximal end, to tip of metacarpal 1	Height of distal metacarpal symphysis*
C. hibbardi			
UMMP no. 24753 (left)	22.0 mm.	5.8 mm.	3.3 mm.
" 26854 "	22.4		3.1
" 26855 "		5.7	
" 26857 "			3.7
" 26856 (right)		6.2	
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	19.3 ± 0.3	5.5 ± 0.1	3.1 ± 0.1
Range	18.6 — 21.2	5.2 — 5.9	2.6 — 3.6
Standard deviation	0.8	0.3	0.3

* From distal end of intermetacarpal space to distal end of facet for digit 3.

No. 26856. Right side, proximal end intact, with about 5 mm. of metacarpal II (including metacarpal tuberosity) and 1 mm. of metacarpal III attached.

No. 26857. Left side, distal end intact, with 5 mm. of the split shaft of metacarpal II and 1 mm. of the shaft of metacarpal III attached.

No. 26858. (Two specimens.) One right and one left metacarpal II, with badly worn and broken portions of the distal and proximal ends attached.

Proximal phalanx, digit 2 of manus.—This bone, UMMP no. 26859 (fig. 1B, table 6), is much larger than in the modern species. This element shows relatively little size variation in my series of Recent birds, thereby emphasizing the importance of the size difference noted. The specimen, from the right side, may not belong to *C. hibbardi,* because of its large size. However, except for size and the

Table 6

Measurements of Limb Elements

Specimens	Proximal phalanx, digit 2 of manus: Length, taken perpendicular to line across digital facet	Proximal phalanx, digit 2 of manus: Greatest breadth	Proximal end of tarsometatarsus, transverse breadth of head
C. hibbardi			
UMMP no. 26859 (right)	9.1 mm.	4.3 mm.	.....
" 26860 (left)	.....	.....	6.5 mm.
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	7.6 ± 0.1	3.8 ± 0.1	5.9 ± 0.1
Range	7.2— 7.9	3.5 — 4.0	5.6 — 6.6
Standard deviation	0.3	0.2	0.4

slightly greater angularity of the conformation of its external side, the fossil agrees closely with *C. virginianus.* It is well preserved, unbroken, and only slightly worn. In addition to some wear on the edges, a small hole has been worn through the thin area just anterior to the middle part of the posterior margin.

Tarsometatarsus.—One fragment, UMMP no. 26860 (figs. 2A-2C, table 6), the proximal end (about 15 mm. long) of a left tarsometatarsus, probably belongs to this species. The fossil is excellently preserved, and, except for a small piece broken from the back of the hypotarsus, exposing the tendinal canals, the details of the articular surfaces are intact. In size this bone agrees with male specimens of *C. virginianus,* but in conformation it differs in the following ways from examples of the modern species which I have examined: the intercotylar prominence is somewhat more rounded in the fossil (this may be due to weathering or wear); the depression just over the posterior edge of the internal cotyla is somewhat more angular and sharply marked in the fossil; the lateral face of the hypotarsus of the fossil bears a more sharply defined ridge leading proximad from the outer proximal

Table 7

Measurements of Distal End of Tarsometatarsus

Specimens	Transverse breadth of shaft below center	Transverse breadth across trochleae	Transverse breadth of middle trochlea	Depth of middle trochlea
C. hibbardi				
UMMP no. 26861 (left)		6.8 mm. (approx.)	2.6 mm.	3.4 mm.
" 26862 (right)	3.0	6.6	2.4	3.1
KUMVP no. 3981 (right), type	3.1	7.0 (approx.)	2.9	
C. virginianus				
6 ♀♀, 2 ♂♂				
Mean, with standard error	2.8 ± 0.1	6.1 ± 0.2	2.3 ± 0.1	3.1 ± 0.1
Range	2.6 — 3.1	5.6 — 6.7	2.1— 2.6	3.0 — 3.5
Standard deviation	0.2	0.4	0.2	0.2

foramen than does any of the modern specimens at hand. Modern Bob-whites show considerable variation in the proximal end of this bone, however, and most of the differences between the fossil and the most similar of the modern bones can be equalled within the series of modern *C. virginianus.*

Since the type of *C. hibbardi* is the distal end of a right tarsometatarsus, the three fragments representing this element in the present collection are especially important. The most nearly perfect of the three bones, UMMP no. 26862, has been confirmed by Wetmore as representing *C. hibbardi.* The

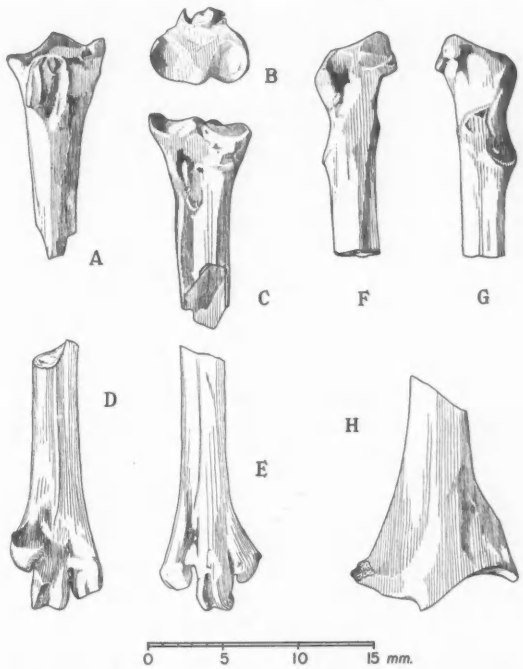

Fig. 2. *Colinus hibbardi*. A, B and C, proximal end of left tarsometatarsus, UMMP no. 26860. D and E, distal end of right tarsometatarsus, UMMP no. 26862. F and G, distal (humeral) end of right coracoid, UMMP no. 26844. H, proximal (sternal) end of right coracoid, UMMP no. 26843.

type, from the right side, lacked the main parts of the outer trochleae, while no. 26862, also from the right side, has all three trochleae intact. As is indicated in table 7, two of the fossils are from individuals slightly smaller than the type. The third specimen, UMMP no. 26863, is too fragmentary to be measured.

No. 26861. Distal end of a left tarsometatarsus; shaft broken just above the distal foramen; trochlea for digit 2 missing. Otherwise similar to no. 26862, though from a slightly larger individual.

No. 26862 (figs. 2D and 2E). Fragment, about 18 mm. long, of a right tarsometatarsus; shaft broken approximately at the middle of the bone. Trochlea for digit 2 strong and well developed; shorter than trochlea for digit 3 and produced posteriorad, with result that, from medial view, trochlea 2 does not cover any of trochlea 3; a decided knob (wing of trochlea for digit 2) projects posteromediad from the posterior medial edge of the trochlea; middle trochlea as in Wetmore's description of the type—"strong, elliptical in lateral outline, with its lateral faces slightly excavated; a shallow groove extending clear around the articular surface, beginning in a definite depression on the anterior face; the outer flange bordering this groove slightly heavier than the inner, and on the posterior face extending farther up toward the inferior foramen." Outer trochlea (for digit 4) strongly developed; in lateral aspect the two flanges bordering the groove of the articular surface appearing as two ellipses, the outermost smaller and somewhat posterior to the inner one; the inner flange slightly heavier and produced farther distally, as well as anteriorly, than the outer flange; however, the outer flange

extending farther proximad on the posterior face than the inner flange; this trochlea slightly excavated on its inner and outer faces; as in the type, shaft "strong, flattened distally, with three sharply angular lines marking tendinal grooves on posterior surface; facet for hallux large and well marked; anterior face with a broad, shallow groove leading down into the relatively large inferior [= distal] foramen."

No. 26863. A fragment of a right tarsometatarsus about 18 mm. long. All three trochleae are broken off at the level of the distal foramen, and the shaft is split in such a manner that its breadth cannot be measured accurately. However, in general shape, in conformation of the tendinal grooves on the posterior side, in the shape and position of the facet for the hallux, and in conformation of the groove on the anterior face leading down to the distal foramen, this fossil agrees completely with UMMP no. 26862 described above.

DISCUSSION

The frequency of occurrence of bones of *Colinus hibbardi* in the collections thus far examined indicates that this species must once have been abundant, or it may indicate that the bone deposit accumulated under some sort of selectivity, as would be true if, for instance, these fragments represented the remains of pellets of predatory birds (see Hibbard, 1950). It will be interesting to see if more material, when it becomes available, will confirm the difference in proportion between *hibbardi* and *virginianus* which is suggested by the specimens here described, namely, that the Pliocene species, while larger throughout, tends to be proportionately longer-winged than the modern form, with relatively less difference in the dimensions of the leg bones. If this proves to be so, then we may picture the Pliocene quail as a stronger flyer than the modern Bob-white—perhaps even a migratory form.

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THE AVIFAUNA OF NIIHAU ISLAND, HAWAIIAN ARCHIPELAGO

By HARVEY I. FISHER

Niihau Island lies about 150 miles northwest of Honolulu and is about 25 miles west by south of the island of Kauai. It is approximately 17 miles long, and its greatest width is five miles. The highest elevation is 1281 feet, at Paniau, on the northeast coast.

The southern and northern ends and the western side of this volcanic island (fig. 1) are low, with sand and lava beds sloping gently to the sea. The east-central part of the island, from Halalii Lake on the south to Puu Alala on the north, is made up of rugged lava mountains rising toward the east where 1000-foot cliffs drop to the water's edge. In this mountainous portion is a rolling plateau (800 to 1100 feet) between Mount Kaeo and Pueo Point which extends north to Paniau; this plateau is formed of the heads of the numerous canyons that cut eastward through the cliffs to the sea and by the basins of the Kaumuhonu, Puniopo and Kahunalii valleys extending westward.

In the lowlands are intermittent lakes. Halutu and Halalii lakes to the south were nearly dry when we visited the island. Apana Reservoir was broken and dry. The only surface water present was in Halutu Lake, in the small ponds north of Kiekie and southwest of Puuwai, and in the numerous sumps dug in tidal waters to supply brackish water for the livestock. Only cistern water is available for household use. At times, this supply must be augmented by using coconut milk and cactus pears (panini). The large acreages of cactus (*Opuntia*) established on the island by the Robinson family also are a major source of water for cattle. The above statements indicate that the island is extremely dry; it probably has an annual rainfall of less than 15 inches. Although the aridity is no doubt due to the fact that the mountains of Niihau are relatively low and that Niihau is in the lee of Kauai's 4500-foot mountains, the aridity is increased by the absence of any significant amounts of forest on Niihau itself.

There is no native forest of any sort left on the island; it apparently was destroyed by goats liberated by Captain Vancouver in 1794. Niihau was the first Hawaiian island to have goats released on it. Wilson and Evans (1890-1899:viii) noted the absence of the forest, but land mollusks of the genus *Carelia* were found. This indicated to them that there formerly were damp forests. Kiawe trees (*Prosopis chilensis*), started from seed by the Robinsons, are now the predominant vegetation of the lowlands, the mountain canyons and the steep slopes. Coconut palms (*Cocos nucifera*) are not found in abundance; a few acres here and there in the lowlands constitute the only plantings, although occasional trees are found elsewhere. Grasses of eleven kinds and indigo (*Indigofera suffruticosa*) form the main plant cover of the plateau. A nearly pure stand of pasture grasses, free from weeds because of the browsing of sheep, is to be found between Kiekie, Nonopapa and Halutu Lake. This was the only green spot on the island at the time of our visit and was the result of a recent rain in that area.

Although cactus is scattered over most of the island, it is most abundant and is the predominant plant in the region around the north side of Apana Reservoir. Unfortunately, the cactus is being killed out by a blight that reached the island within the last few years. In a few small areas of eroded soil east of Mount Kaeo a reforestation program has been initiated with varying degrees of success. One large area near Paniau has been taken over completely by koa haole (*Leucaena glauca*), an introduced shrub. It is so thick in this region that one cannot walk between the spindly trunks that rise 12 to 20 feet in height.

Land use on Niihau is limited to ranching operations, and it has been for the last three-fourths of a century. Because the feral goats were in competition with domestic stock, the owners, starting about 1890, made every effort to eliminate them. By 1912 the last goat had disappeared. Since that time cattle, horses and sheep have ranged over

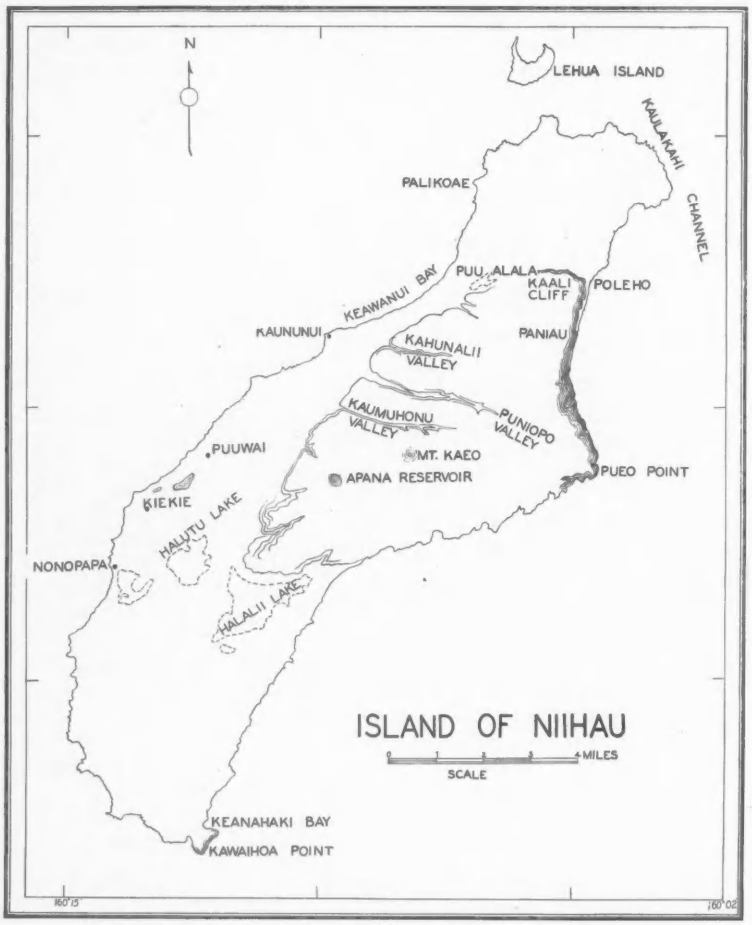

Fig. 1. Islands of Niihau and Lehua, Hawaiian Archipelago.

the entire island, subject to available water. Despite this extensive use the care of the owners has prevented overgrazing. There is much more vegetation now than there was 35 years ago. Bee-keeping has been an important phase of operations of the last half-century. The only areas under cultivation are small household gardens; there is not sufficient water for most crops.

Feral pigs exist in great numbers in all the lowland. Evidence of their rooting activities is everywhere. They are used as food by the Hawaiian population, but their numbers seem to be on the increase. Their success may in large part be the result of the bountiful supply of kiawe beans on which they feed. The cosmopolitan rat (*Rattus rattus*) is present in considerable numbers, but perhaps the most important mammalian predator of birds is the feral cat. Stories of the ferocity and abundance of these cats are almost legendary. Running them down with horses used to be a favorite sport. The mongoose (*Herpestes griseus*) is not present as it is on some other Hawaiian islands. No feral rabbits are to be found on Niihau; they are numerous on the nearby islet of Lehua. No dogs are allowed on the island. Although pigs, rats and cats are everywhere, ground-nesting birds such as the Ring-necked Pheasant, California Quail and Domestic Turkey are flourishing. The populations of pheasants and quail on Niihau seem to be higher per unit of area than in comparable areas on islands where the mongoose is present.

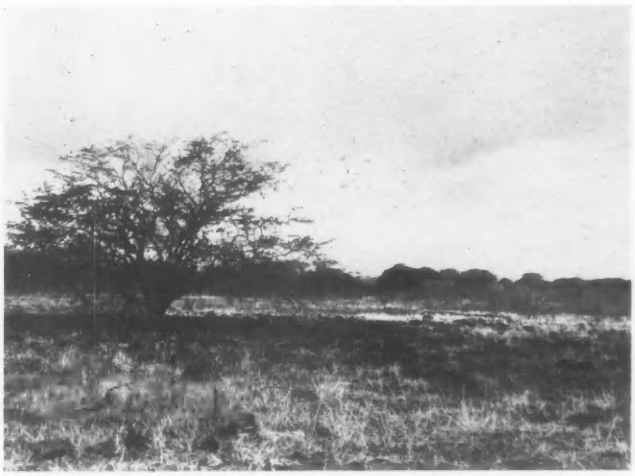

Fig. 2. Lowland vegetation two miles southeast of Nonopapa, Niihau.

In the late 1880's, employees of Lord Rothschild visited the island to collect specimens to be used in preparing his "Avifauna of Laysan and the Neighboring Islands." At about the same time Scott Wilson studied the birds of Niihau as part of his taxonomic and distributional work on Hawaiian birds. Since the turn of the century the only ornithologist to visit the island was Mr. George Munro, who spent a short time there in 1939.

During the summer of 1947 Mr. A. E. Robinson, one of the owners of Niihau, invited three members of the staff of the University of Hawaii to come to Niihau to make collections and to study the birds, insects and plants. Without the generosity and interest of Mr. Robinson the expedition would never have been possible. We remained on the island from August 12 through August 16 as guests in his ranch home. He provided horses and guides to enable us to visit all parts of the island in the short time available.

In the five days of work on the island, some 90 miles were covered on horseback. Forty-five specimens of birds were collected, and notes were made on populations, distribution and natural history. Because of the scarcity of certain introduced species such

as the Prairie Chicken, the "Hawaiian Chicken," *Gallus gallus,* and the Bush Partridge or quail (*Coturnix*) no specimens of them were taken. One day was spent on the small cone island of Lehua, which lies just off the north end of Niihau.

The avifauna of Niihau has particular interest to the ornithologist because all native birds have been eliminated and their places taken by successful exotic birds. Since the introduction by humans of exotic species has been under the control and supervision of one family, it is possible to note dates of introduction of many species. It is even feasible to judge the probable dates of entry of birds which have moved without human aid to

Fig. 3. North slope of Mount Kaeo from Kaumuhono Valley, Niihau.

Niihau from Kauai Island some 25 miles upwind. These latter dates are fairly accurate because the Robinson family has long been interested and informed on the birds of both Kauai and Niihau. The present report on the birds of Niihau will, it is hoped, be of importance to future ornithologists making critical studies of temporal distribution and of evolutionary changes in the exotic birds as these birds adapt themselves to the environments provided by the island.

As Niihau again becomes covered by some sort of vegetation, we can expect certain birds to establish themselves there. Aside from exotics the most probable avian pioneers in the area would be emigrants from Kauai which, as mentioned previously, lies up the trade winds from Niihau. Wilson and Evans (1890-1899:ix) noted that *Vestiaria coccinea,* the Iiwi, and *Himatione sanguinea,* the Apapane, were sometimes found on Niihau, apparently carried over by winds from Kauai, but that they soon perished. Both species are inhabitants of forest canopies. Neither is a strong-flying bird that might be expected to undertake this over-water trip of its own volition. We know that the White-eye (*Zosterops palpebrosus*) ,the Mynah (*Acridotheres tristis*) and others have established themselves on Niihau from Kauai stock. In the light of these events it is not unlikely that many other birds now on Kauai might arrive and survive on Niihau if the ecological conditions were proper for them. We might expect the Elepaio (*Chasiempis sandwichensis sclateri*) and the Kauai Thrush (*Phaeornis obscura myadestina*), which

are birds of the forest and brushland, to become established. Species such as the Amakihi (*Chlorodrepanis virens*) and the Creeper (*Paroreomyza bairdii*), birds of the understories of the forests, might not be expected to spread to Niihau as rapidly; however, they are present on all forested islands of the Hawaiian Chain. *Loxops caeruleirostris*, the Akepa, a relatively strong flyer and a bird of the high forest canopies, is another species that could arrive on Niihau.

Hence it would seem of significance to record the present avifauna. As each species is discussed an attempt will be made to indicate its relative abundance, date of introduction, distribution on the island, and the specific niche it now occupies.

Diomedea nigripes. Black-footed Albatross. This species was observed at sea about five miles east of Niihau. It is frequently seen offshore around the main group of Hawaiian Islands, but seldom does

Fig. 4. West side of eastern arm of Lehua Island, showing lines of erosion used as nest sites.

it land on these islands. Munro (1946:28) has recorded one individual alive, although sick, on the Kailua Beach of Oahu. It is reported breeding on Kaula Island, 15 miles southwest of Niihau, and there are sight records (Caum, 1936) for it on Lehua.

Diomedea immutabilis. Laysan Albatross or Moli. Not observed on Niihau or Lehua during the period of observation, and no evidence of nesting could be found. Young of this species usually remain on the nesting grounds until late July or early August. If breeding had occurred this year, young probably would have been found. Munro (1944:18) stated that it sometimes nests on Niihau. Mr. Robinson has also noted occasional nesting there. Sporadic nesting of this sort may be expected in species extending their range as this albatross is apparently doing. Moir (1946:81) reported a pair performing part of the characteristic dance at Makahuena Point, Koloa, Kauai, in March, 1945, and in March, 1946. Although this probably was post-breeding behavior (egg-laying occurs in December and January usually) we may consider these birds as pioneers in a new or long-deserted breeding area. More recently, Fisher (1948:66) recorded the successful breeding of one pair on Moku Manu Islet off Oahu.

Diomedea albatrus. Short-tailed Albatross. Wilson and Evans (1890-1899:xxv) cited Rothschild as reporting this species just off Niihau.

Puffinus pacificus cuneatus. Wedge-tailed Shearwater or Uau Kani. At 11 a.m. on August 11 as we approached Niihau, between that island and Lehua, many of these birds circled over our sampan.

This species was observed on August 15 flying about the eastern cliffs of Niihau; no nests or burrows were observed. The following day thousands of these birds were found on Lehua. For the most part, single individuals were found with newly-hatched young; a few were still on eggs. In general, nesting sites were wind- and water-eroded pockets in the cinders and under more or less horizontal ledges of lava. Only a few burrows were found. In just a few small patches was there enough soil for burrows; apparently, as the cinder and lava disintegrate, the particles are blown or washed down the steep slopes into the sea, leaving only hard, bare structures.

Puffinus nativitatus. Christmas Island Shearwater. This shearwater was not observed on Niihau, but there was insufficient time to search likely places on the cliffs. Single adults were in two instances found under lava ledges on Lehua.

Puffinus newelli. Newell Shearwater or Ao. Three individuals having the characteristic white spots on the side of the neck and high on the flank were observed in the channel between Kauai and Niihau on August 16. Although this sight record of so rare a bird is perhaps of little value, there are no other common petrels or shearwaters in the area with which it could be confused. Local ornithologists on Kauai have from time to time reported unidentified birds resembling this species. Henshaw (1902:118) credited Mr. Francis Gay with securing specimens from Kauai.

Pterodroma leucoptera hypoleuca. Bonin Island Petrel. Only three individuals were observed, and these were seen about five miles off the northeast corner of Niihau. However, Wilson and Evans reported that Francis Gay sent in specimens from Niihau.

Bulweria bulwerii. Bulwer Petrel. Four were observed in the Kaulakahi Channel east of Niihau.

Oceanodroma castro cryptoleucura. Hawaiian Storm Petrel or Akeake. This species, which was first described from Kauai, was observed in the Kaulakahi Channel in 1893 by Palmer. Specimens were taken on Niihau by Francis Gay before 1900 (Henshaw, 1902:118; Rothschild, 1893-1900:53).

Phaëthon rubricauda rothschildi. Red-tailed Tropic Bird or Ula. On the sheer cliffs of Kawaihoa Point at the south end of Niihau about 20 individuals were observed. Although nests were not actually seen, it was apparent from the activities of the adults that young were present on some of the ledges. Birds were also present along the cliffs between Poleho and Pueo Point. The population on Lehua was estimated at 400. A few of these were on eggs on August 16, but most nests contained nearly-fledged young. Nest sites were in wind-eroded pockets (fig. 4) and under ledges; they were not in "tight" colonies but were to be found wherever suitable conditions were present, from sea level to the top of Lehua (700 feet). Wilson and Evans stated that it was breeding on the cliffs of Niihau in 1890.

Phaëthon lepturus dorotheae. White-tailed Tropic Bird or Koae. One individual was observed on the cliffs below Paniau, Niihau, and two flew over Lehua for some time. No evidence of nesting was found at either place.

Wilson and Evans made the statement that this species is common on all islands of the Hawaiian Group. Actually, it has been reported only from the five larger islands on the southeast end of the group and is restricted to certain small areas on them; individuals are, of course, frequently seen soaring in favorable locations away from these small areas.

Sula sula rubripes. Red-footed Booby, or "A" in Hawaiian. This species was abundant in the channel between Kauai and Niihau. Despite the fact that no birds were observed perching on Niihau it seems certain, judging from their activities about the steep cliffs on the eastern side of the island, that they do breed there. The colony of about 3000 individuals on Lehua was through with all nesting activities on August 16; no eggs were present and all young birds observed were capable of flying.

Sula leucogaster plotus. Brown Booby or "A". Munro (1944:35) stated that this species nests in cliffs on Niihau. Bryan and Greenway (1944:98) reported sight records off Niihau. I saw but one individual; it was flying east over Lehua toward Kauai.

Sula dactylatra personata. Blue-faced Booby or "A". None was found on Lehua or Niihau, but Caum (1936) found a few nesting on Kaula Island, a few miles west by south of Niihau, and reported their presence on Lehua. It is not unlikely that they may nest on the sandy areas at the north end of Niihau.

Fregata minor palmerstoni. Frigate-bird or Iwa. Although this species can be observed from time to time around most of the Hawaiian Islands, it is not abundant east of Oahu and its main breeding range probably lies west of Niihau. It is reported nesting on Kaula, but I found no nesting activity on

Niihau or Lehua. Six birds were seen at Kawaihoa Point on August 13, and three were present over Lehua on August 16.

Nycticorax nycticorax hoactli. Black-crowned Night Heron or Aukuu. This emigrant from America has spread widely over the eastern end of the Hawaiian Islands wherever suitable habitats are available. The absence of streams and permanent water on Niihau make the island almost uninhabitable for this species. Only one individual was found; it was near the small pond north of Kiekie. Formerly, there was a colony around Apana Reservoir which is now dry. Bryan and Greenway (1944:100) listed no records from Niihau, but refer to Rothschild, to Wilson and Evans, and to Henshaw, who all inferred that before 1900 it was on "all islands." Munro (1944:41) said it was uncommon on Niihau. It would seem quite likely that the increasing aridity of Niihau, occasioned by the loss of the native forest, has all but eliminated this species. It will be interesting to see if the population builds up again with increase in water resources as the vegetation is restored in part.

Anas wyvilliana wyvilliana. Hawaiian Duck or Koloa. As with the heron, the decrease in suitable habitat on Niihau has adversely affected this species. Only one sight record (Halalii Lake) was made during the present study. In 1902, Henshaw reported its presence in considerable numbers on "all islands," and Munro (1944:43) stated that originally it was common on all islands except Lanai and Kahoolawe. Palmer (Rothschild, 1893-1900:273) observed large flocks on lakes on Niihau, on some occasions "not less than 100." Today there is a good population on Kauai and scattered bands of a few individuals on some of the other eastern islands of the Hawaiian Group. Should environmental conditions on Niihau favor it, this duck would undoubtedly repopulate Niihau from Kauai.

Tympanuchus. Prairie Chicken. Mr. A. E. Robinson told us that the Prairie Chicken was brought to Niihau about 1934 and was released on the high, grassy plateaus in the east-central part of the island. On August 15 the writer saw two individuals near Paniau. Six more were observed in the same region by other members of the party. There seemed to be little doubt of the identification, but specific determination was impossible because, at the owner's previous request, no specimens were taken. Munro (1944:148) stated that *T. cupido* is supposed to have been liberated on Kauai.

Gallus gallus. Hawaiian Chicken. Chickens of a variety supposedly kept in a semi-wild state by the old Hawaiians have been secured from private individuals on Kauai. These were liberated within the last few years near a waterhole at the base of Kaali Cliff, west of Poleho. Approximately a dozen of these birds were found there, but none was observed elsewhere on the island. No specimens were taken.

Coturnix. Pectoral Quail; known on Niihau as Australian Bush Partridge. Mr. Robinson informed us that this bird spread all over the island after being released "within the last 15 years." However, I found them only in the grassy plateaus in the east-central part of the island; three at 600 feet elevation, one mile north of Kaeo, and three at 1000 feet just west and south of Paniau. No specimens were secured.

Lophortyx californica. California Quail or Manu Kapalulu. This species was first established on Niihau about 1900, but there have been several subsequent importations directly from California, one from Arizona, and several from previously established stock on Kauai. Specimens taken ranged from typical *L. c. brunnescens* to typical *L. c. californica*.

These quail are abundant in the kiawe-covered lowlands at the base of the mountains and in the canyons. They are concentrated especially about the water sumps, but coveys are widespread. Literally hundreds of these birds were to be found feeding, in groups on the ground, and perched in kiawe trees around the waterholes. In the flatter, more open coastal areas they are not as numerous, but on checking several locations it was found that even here one could see on the average more than 100 birds in a half-mile walk. In the grassy, plateau country there were few birds; one could ride for half an hour and see only 10 or 15 birds. Available water in this area is probably the limiting factor.

Phasianus colchicus. Ring-necked Pheasant or Kolahala. As far as could be determined from field observations, the population on Niihau is a mixture of two or more forms of this species. The lowlands have relatively few birds, except in the immediate vicinity of the waterholes. The open lava fields have almost none; the thickets of kiawe present the best cover in the lowlands. The birds were abundant in the tall-grass cover on the east, south and west slopes of Kaeo, and in the indigo vegetation one mile north of Kaeo. The grass and weeds of the plateau have by far the highest numbers,

quite in contrast to the distribution of the California Quail. Pheasants are perhaps only one-tenth as numerous as the quail, on an island-wide basis.

Although residents informed me that young pheasants could be found any time between late February and early December, all the young I saw were approximately half-grown.

Pavo cristatus. Peafowl or Pikake. This species was introduced on the Hawaiian Islands about 1860s and was released on Niihau in the 1890's. On Niihau, this species is almost entirely limited to the lowlands from Palikoae in the north to Keanahaki Bay in the south. The greatest concentration was at the base of the mountains opposite Keawanui Bay (150 found around one small waterhole), but from Kiekie south a pair could be found about every half-mile. None was observed in the mountains above Apana Reservoir or in any of the plateau country. Their range apparently extends only a short way up the various valleys that open to the west. One of the staple foods of the peafowl is the bean-like seed pod of the kiawe trees. The stomachs of the two specimens taken were filled with three-inch parts of pods containing the beans.

Meleagris gallopavo. Turkey or Pelehu. Thousands of these birds are distributed over the entire island. They are most abundant in the lowlands covered by kiawe trees, on the beans of which they feed, but the greatest concentration is from Kaumuhonu Valley north to Kaali Cliff. The southern end of the island has only scattered bands, as does the indigo and grass plateau.

Mr. Robinson said they had liberated White, Bronze and "Mexican Black" turkeys at various times. Counts on the stock predominating in three different areas showed a consistent ratio of eight Bronze Turkeys to three White Turkeys.

Fulica americana alai. Hawaiian Coot or Alae Awi. I saw no members of this species on Niihau, but Henshaw (1902:100) stated it was found on all islands, as did Munro (1944:54). Francis Gay collected it on Niihau. The fact that the natives of Niihau have a name for it probably indicates that it used to occur there, if it does not still occur there periodically. Munro (*op. cit.*) believed that it dispersed from Niihau when the temporary lakes or ponds dried up.

Pluvialis dominica fulva. Golden Plover or Kolea. This plover is to be found on all the Hawaiian Islands throughout the year; however, relatively few remain over the summer months. The birds were found on all the lowlands of Niihau and were especially numerous around the dry lakes. About 1000 were found in one flock in the Halutu Lake bed; most of these were in winter plumage. Although the species may not breed here, individuals in breeding plumage were not uncommon and were not usually in large flocks as might be expected of migratory individuals.

Numenius tahitiensis. Bristle-thighed Curlew or Kioea. Only two individuals (at Puu Alala and Kawaihoa Point) were found of this fall and winter visitant to the islands; like the Golden Plover, a few individuals remain over the summer. Although nesting in Hawaii of this and other shorebirds is usually considered improbable, there seems to be no reason why occasional pairs should not breed in suitable areas. Mr. John Rennie, formerly of Niihau, reported a curlew nesting there many years ago.

Heteroscelus incanus. Wandering Tattler or Ulili. Three individuals were observed on August 16 on Lehua.

Arenaria interpres interpres. Ruddy Turnstone or Akekeke. Of all the shorebirds on Niihau, this species was the most abundant and was found all over the island. A few flocks up to 20 in number were present on the sand beach at Kaununui; 250 in one flock were feeding on the short-grass flats at Puuwai; several thousand were feeding in the bed of Halutu Lake, and about 50 were found on the slopes of Kaeo, where the grass was sparse. Two were flushed from a bare spot on the grass plateau at the head of Puniopo Valley.

Crocethia alba. Sanderling or Hunakai. One was seen at Halutu Lake and one on Lehua.

Himantopus himantopus knudseni. Stilt or Aeo (Io). The stilt is one of the rare endemic birds. Munro (1944:60) believed the species was down to about 200 birds, but this now seems somewhat low in view of the flocks on Oahu, Niihau and Kauai. He also stated that the existing population appeared to migrate between Oahu and Niihau; this remains to be shown.

On Niihau, nine individuals were found at Halutu Lake, four on the pond north of Kiekie, and 49 on the water southwest of Puuwai. There is no question that the numbers have decreased greatly in the last 50 years due to increasing aridity and to increased predation by man, for Perkins (1903:453) found it common on nearly all the larger Hawaiian Islands, including Niihau.

Sterna anaethetus lunata. Gray-backed Tern or Pakalakala. Bryan and Greenway (1944:118)

included Niihau in the list of records for the Hawaiian Group; this was apparently based on Rothschild (1893-1900:285), for I have found no other positive records for Niihau. Caum (1936) found it on Kaula, and it is known from Kauai.

Sterna fuscata oahuensis. Sooty Tern or Ewaewa. This species was present in Kaulakahi Channel, and two birds were found on Lehua. Oddly enough, the species has never been recorded from Niihau, even as a visitor, despite the fact that it is present on Kaula and other islands to the west and on islands to the east of Niihau.

Anoüs stolidus pileatus. Noddy or Noio. Only one member of this species was found; this was taken at the northeast corner of Niihau. The species has never been reported from Niihau, but there are sight records from Kaula and Lehua.

Anoüs minutus melanogenys. Hawaiian Tern or Small Noio. About 200 were found on Lehua, standing on rock ledges at waterlevel or in caves. The "Noio Caves" of Lehua are at sea level, and the floor is covered with tidal water. One of these caves extended about 50 feet into the cliff. On ledges in the upper and back portions of these caves there were 23 nests, most of which contained nearly-fledged young.

A similar nesting situation is in a cave on the north side of Moku Manu Islet off Oahu. This type of nesting site is quite in contrast to that on Midway Island where the birds nest in the ironwood trees, *Casuarina*, and *Scaevola*, and to that on the Mokapu Cliffs of Oahu where the birds breed on narrow, open ledges.

Geopelia striata striata. Barred Dove or Ehako. The most abundant bird on the kiawe areas is this dove; it is the most numerous species on Niihau. A few were found feeding on Lehua; flights were observed between Niihau and Lehua. At present on Niihau it is relatively scarce in the mountain and plateau regions, due perhaps to absence of water, but small feeding groups are found even there. Around waterholes in the lowlands it was not unusual to find several thousand; estimates of 2600 and 3100 were made at two water sumps. Thus, it is evident that the bird has adapted itself to conditions on Niihau since its introduction and now utilizes the entire island, at least for its feeding. No nests or young were found.

Streptopelia chinensis. Chinese or Lace-neck Dove or Ekaho. Not nearly as abundant as the Barred Dove, this dove presents the same pattern of distribution—numerous in the lowlands and few in the mountains and plateaus. It was first found on Niihau about 1930, and apparently came to the island from Kauai.

Asio flammeus sandwichensis. Short-eared Owl or Pueo. Owls were seen only twice: one bird at Nonopapa, in the middle of a large area of introduced pasture grasses, and two birds perched in kiawe trees at Puu Alala. The Pueo was a common bird in Hawaii before 1900, but on islands other than Niihau much of its habitat has been taken over for agriculture. Why it is relatively scarce on Niihau is unknown.

Alauda arvensis. European Skylark or Manu Palaika. Francis Sinclair brought this species to Niihau before 1920 and later took some of this stock to Kauai for release there. Nowhere on Niihau is it abundant, but it was found everywhere except in those areas where kiawe or koa haole formed extensive, dense thickets. It occurred on all grassy areas in the sand dunes and on the plateaus, in short-weed patches in open stands of kiawe; some were even observed feeding on the steep, barren slopes of Lehua. Usually, the birds were seen as singles or doubles, rarely in groups of three or more. Specimens taken were typical of the species.

Acridotheres tristis. Mynah or Piakelo or Pihaekelo. The Mynah apparently arrived on Niihau without human aid, some time after 1870. Mr. Robinson has frequently seen them flying in either direction in the middle of the channel between Kauai and Niihau. The Mynah is ubiquitous in the lowlands, but very few are to be found in the drier mountains and plateaus.

Sturnella neglecta. Western Meadowlark. This species was introduced to Niihau in 1934, according to Mr. Robinson. It apparently did not establish itself, for no birds have been seen in recent years. It is, however, well established on Kauai.

Zosterops palpebrosus. White-eye. The White-eye was first introduced to Hawaii (Oahu) in 1929. From Oahu it has spread unaided to the other large islands, including Kauai and Niihau. On the latter its numbers are still small, as a result perhaps of recent arrival or adverse environmental conditions. On Oahu this species frequents garden shrubbery and other moist thickets. On Niihau the

birds were to be found almost exclusively in the low, dense growth around the ranchhouse at Kiekie; a few were found in kiawe thickets near waterholes.

Munia punctulata. Ricebird or Manu Ailike. The Ricebird, since its introduction to the Hawaiian Islands (Oahu?) in 1865, has spread to all the islands. On Niihau it is a resident of the open kiawe growth where grass and weed patches are interspersed. I never found it in extensive thickets.

Richmondena cardinalis. Cardinal or Ulaula. Introduced to Kauai about 20 years ago, this species has become well established and has populated Niihau on its own. Nowhere on Niihau are the birds as abundant as, for example, in the moist gardens of Honolulu, but one may find singles or pairs in all parts of the island. They are most numerous around the water sumps in the lowlands.

Carpodacus mexicanus. House Finch or Ai-nikana. After Barred Doves, this species is the most abundant on Niihau. It was not introduced by man; it came apparently from Kauai where it was introduced many years ago. The House Finch is present everywhere on the island. Nests and eggs were found beneath shrubbery on the cliffs above Puu Alala. No red-crowned birds were seen or collected; all had yellow to orange crowns.

DISCUSSION

As may be observed in part from the foregoing accounts of species occurring on Niihau, the longitude (160°) of this island corresponds closely to a faunistic division between eastern and western islands of the Hawaiian Chain. Niihau and all islands to the east are relatively new geologically; those to the west are old. The eastern islands are high, sharp mountains which have not been worn down. Forests and soil are present. The middle third of the Hawaiian Chain consists, for the most part, of low, barren rocks with little soil, little plant growth of any kind, and very few trees. The rocks represent the tops of submerged mountains. Islands to the west of Gardner Pinnacles are extremely low, sand atolls with little native plant cover (other than *Scaevola*) at the present time.

Conditions on these islands were not always as described above; we know, for example, that Laysan Island had, within historical times, groves of sandalwood trees, *Santalum*, and dense thickets of brush. However, at the present time it is possible for the Hawaiian Islands to be subdivided into these three geographical regions which are more or less distinct in fauna and flora. The eastern division includes the larger eastern islands from Hawaii west to and including Niihau. The middle region extends from Kaula and Nihoa to Gardner Pinnacles. The western region includes the islands from Laysan to Kure.

To show this subdivision in the avifauna I have prepared figure 5. Not included are the migratory shorebirds and ducks, or any chance visitors.

It is apparent that there is considerable overlap between the west and middle parts, but there is a rather sharp line of separation in the avifauna in the region of Niihau. This is even more apparent than the figure would indicate, for the species that overlap most, *Puffinus pacificus cuneatus* and *Bulweria bulwerii*, breed in the eastern division only on three or four small islands off the coasts of Oahu and Hawaii. Further, the eastward extension of *Sula sula rubripes*, *Sterna*, and *Anoüs stolidus*, as shown in the figure, is based on breeding records on Moku Manu and Manana Islets off Oahu, and should not be considered typical of the larger eastern islands. The extension of *Diomedea immutabilis* into the eastern section is based on a single nesting on Moku Manu.

It should be noted that these small islands off Oahu, Molokai and Hawaii are ecologically similar to the middle section of the Hawaiian Chain. It has been reported that in 1890-1900 there were no seabirds nesting on these islets and that their populations there were wiped out by the Hawaiians who relished the meat of young petrels, shearwaters and terns. If this be true, the present breeding populations on these rocks are pioneers in reoccupation.

From the data in figure 5 one may also speculate on the species most likely to inhabit Niihau if there is a major change in ecological conditions (see p. 34). With increased water resources and subsequently greater plant growth, species from the

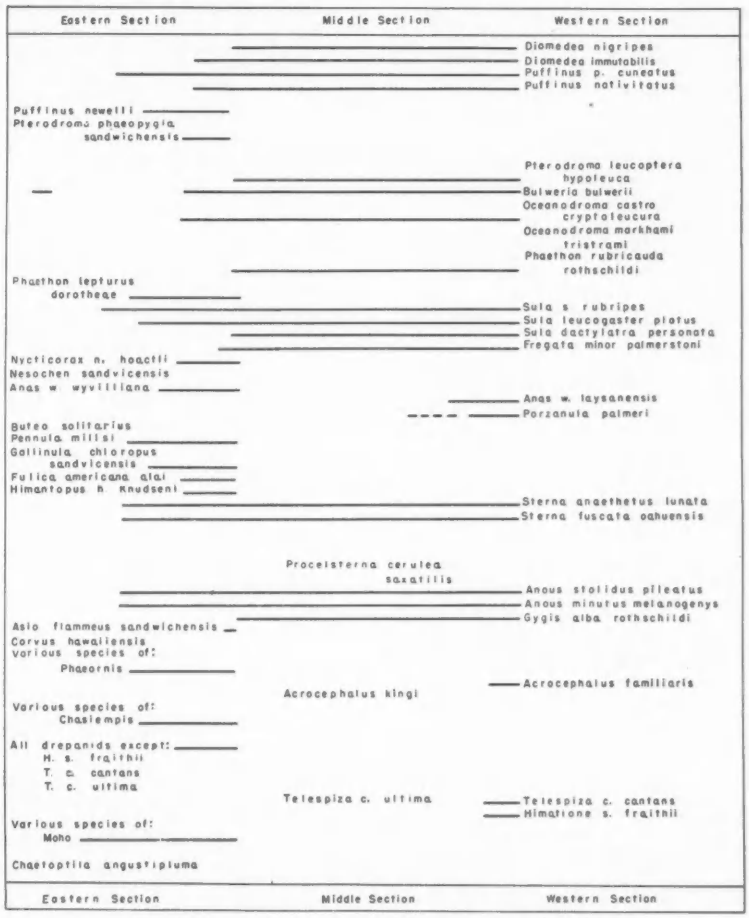

Fig. 5. East-west distribution of birds on the Hawaiian Islands.

eastern end might inhabit Niihau. With greatly increased aridity, less vegetation and possible human retreat from the island, western and middle section species may move in in greater numbers.

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Department of Zoology, University of Illinois, Urbana, Illinois, May 10, 1949.

STOMACH ANALYSIS OF A GROUP OF SHOREBIRDS

By WILLIAM G. REEDER

Aside from scattered reports, the food habits of shorebirds have been very poorly documented. Bent (Bull. U. S. Nat. Mus. 142, 1927; *ibid.*, 146, 1929) lists insects, marine worms, crustaceans, leeches, snails and minnows as comprising the dominant food staples of the shore feeders. Grinnell, Bryant and Storer (The Game Birds of California, Univ. Calif. Press, 1918) are equally general in their analysis of the food habits of this group. Apart from the ornithological interest, knowledge of the feeding habits of shorebirds is necessary in order to determine the extent of predation on invertebrate animals of the marine intertidal zone. Great numbers of migratory birds are present periodically on the coast of southern California. The invertebrate animals of the mud and sand flats and marsh areas undoubtedly are the primary foods of these birds, which appear on the coast in July and reside there until May. Thus the predation is carried on during and after the breeding season of many of the invertebrate forms.

In this study, twenty-seven birds of eight species were collected. Of these, fifteen were taken while feeding on tidewater mud-flats near Sunset Beach, Orange County, California, on May 6 and May 19, 1949. The remainder were obtained while feeding on the sandy beach at Point Mugu, Ventura County, California, on May 8, 1949. The animals were shot and frozen immediately on dry ice and were retained in frozen condition until the alimentary tract was dissected. The stomach and proventricular contents of each bird were preserved in 95 per cent alcohol. Intestinal contents revealed few identifiable body parts of animal prey and thus these were not analyzed.

In the avian digestive processes, soft-bodied animals are almost immediately reduced to fragments, many of which are not recognizable. For this reason, accurate percentage composition data are almost unobtainable. The number of invertebrate individuals comprising the bulk of the stomach contents is often impossible to determine. However, the species forming the predominant food of an individual bird is usually obvious. In most of the shorebirds taken one animal or group of animals dominated the diet of each bird. The proportion of each item in the food mass of a bird has been estimated. The percentage of sand found in the alimentary tract varied from approximately 10 to 60 per cent of the total contents. It was not apparently correlated with species or food habits of the birds.

I wish to acknowledge the willing assistance of Dr. Olga Hartman, of the Hancock Foundation, University of Southern California, for her identification of polychaete fragments and of Dr. J. N. Belkin, of the University of California, Los Angeles, for examination of insect remains.

Charadrius semipalmatus. Semipalmated Plover. One specimen; Point Mugu. Twenty-two distinct individuals of *Emerita analoga*, the sand crab, were recovered. All were immature animals, reaching a length of three to five millimeters. The material comprising the greater part of the food mass was evidently finely ground particles of this decapod. Fragments of several varieties of beetles were present, most of which represented the family Tenebrionidae, or darkling beetles, which are typical of dry, warm regions.

Charadrius nivosus. Snowy Plover. Three specimens; Point Mugu and Sunset Beach. In both specimens from Point Mugu, sand crabs were recovered, with fragments of this species comprising about 80 per cent of the stomach contents. Identifiable elytra indicated the presence of beetles of the families Buprestidae, the woodborers, of the Tenebrionidae, the darkling beetles, and of the ground beetles, Carabidae. These three groups of beetles are common near the vegetation of the sand dunes and also in the areas just above the strand, the woodborers often being found in driftwood. The color of the contents was whitish yellow and no algal filaments were noted, indicating little or no mud-flat feeding. The specimen from the mud-flats of Sunset Beach contained fifteen larvae of ephydrid

brine flies, elytra of four ground beetles, and the remains of three unidentified winged insects. Chitinized jaws of seventeen nereid polychaetes were recovered. Undoubtedly this portion of the animal is retained for considerable periods within the gizzard. Three chelipeds of *Pachygrapsus,* the lined shore crab, were also identified.

Ereunetes mauri. Western Sandpiper. Seven specimens; Point Mugu. In each individual, by far the most prominent food animal was the sand crab, *Emerita,* which, in all cases, made up at least 75 per cent of the total food mass. The contents of each stomach were ivory-white, indicating little exploitation of mud-flats. Larvae and adults of the shore fly, *Ephydra,* were present in three of the seven stomachs examined. This fly is often found in immense numbers, as adults, swarming over a marshy or water surface, and as larvae and pupae, beneath the water surface or in windrows along the edge of brackish water. Remains of darkling and ground beetles were recovered from two of the birds, while midges or small flies and true bugs were identified in one stomach.

Crocethia alba. Sanderling. Two specimens; Point Mugu. Immature sand crabs, *Emerita,* made up the entire food mass in both birds. There was no evidence of predation on any other animals of the marine intertidal zone.

Limosa fedoa. Marbled Godwit. Six specimens; Sunset Beach. In five of the six specimens examined, cirratulid polychaetes, most of them identifiable as *Scoloplos* and *Cirriformia,* were the dominant food item. In these stomachs, nereid and other polychaete types were present in lesser numbers, usually comprising less than one-third of the entire contents. The gizzard of one of the birds was about one-third filled with the polychaete *Cirriformia,* while the remaining portion was packed with the proglottid strings of parasitic cestodes. The scolices were attached in the small intestine, which, unfortunately, was excised before examination was completed. The proglottid strings penetrated the pyloric valve, the bulk of the body being situated in the stomach. In the other five specimens, from one to ten shells of the small snail *Melampus* were found. This univalve is typical of mud-flat surfaces and is often found in great numbers in this environment. The univalve *Olivella,* and the bivalves, *Donax* and *Pecten,* were each found as minor constituents of one food mass. In one stomach, the predominant food animal was the larvae of the shore fly, *Ephydra,* of which there were 324 individuals in the one bird. Apparently this individual had been feeding along the edges of a wet *Salicornia* marsh or at a point where shallow saline water was in close proximity to vegetation.

Totanus melanoleucus. Greater Yellow-legs. One specimen; Sunset Beach. The stomach contents of this bird were made up entirely of the bones, scales, and otoliths of a mud-burrowing fish, family Gobiidae. One hundred and twenty otoliths were present, indicating that at least thirty fish had recently been ingested. The otoliths and vertebrae undoubtedly collect like sand in the gizzard and remain within the stomach for a considerable time, this circumstance accounting for the large number of these remains found. The presence of fish in the diet of the yellow-legs has been reported previously (Bartsch, 1899). It was stated that *Fundulus* was eaten by a single bird to the exclusion of other fare. Although these may be instances of individual preference for a particular food type, the role of shorebirds as predators of shallow water and slough dwelling fish has undoubtedly been underestimated. *Clevelandia ios,* which very probably makes up the greater part of the fragments, is an inhabitant of shallow water and mud and is extremely common in certain restricted localities. The yellow-legs, having longer legs than most other shore birds, has the opportunity of capturing prey at greater depths in the mud and water. Only one other bird used in this investigation, namely the Short-billed Dowitcher, contained fish fragments. It will be necessary to collect specimens of yellow-legs during their fall and winter residence in California to determine the extent of their predation on the gobiid fishes. The possibility of seasonal change of food habits must be investigated.

Catoptrophorus semipalmatus. Western Willet. Two specimens; Sunset Beach. Fragments of the shore crab, *Hemigrapsus,* dominated the contents of both birds. This crab is very abundant in the *Salicornia* marshes and on the mud-flats. In its activities as a predator, the shore crab reveals itself prominently and is undoubtedly easy prey for willets and others of the large shorebirds. The defense of these crabs consists of retreat into their elliptical burrows. The efficient hunting of the willets makes this defense ineffectual. The large numbers of these crabs available and their large reproductive potential make them an ideal food animal, which is present in numbers throughout the year. About half of the total bulk of one stomach was formed of fragments of cirratulid sandworms.

Limnodromus griseus. Short-billed Dowitcher. Five specimens; Sunset Beach. Nereid and cirratulid fragments together formed the greater portion of the food material of four of the five birds

examined. Spionid polychaetes, often found on sandy areas on rocky shore lines, were found in but one individual. Small gastropods, including *Melampus,* were a minor constituent of three of the stomachs. Shore fly larvae comprised an identifiable portion in but one stomach. Twenty-seven otoliths, representing at least seven individuals of the mud-burrowing goby, probably *Clevelandia,* were recovered from one stomach. While these fish are evidently available to them, the chief foods taken by the dowitcher are polychaete worms, of any of several families.

DISCUSSION

The differences in feeding habits of the sand or shore feeding shorebirds and those found on the mud-flats are significant. The birds are, in most instances, adapted to prey on the more common of the available forms. On the beaches, immature sand crabs were by far the principal food item. The season at which these immature decapods are common coincides with the period of the year when the shorebirds are on these southern feeding grounds.

Those birds feeding on the mud-flats existed almost entirely on polychaete annelids. These animals are abundant locally in the soft muds and may be found at all seasons of the year. The reproductive rate of the polychaetes and of the decapod *Emerita* is great. Thousands of young are produced each season. Many factors combine to reduce these numbers and maintain a normal population size. Feeding of the enormous numbers of charadriiform birds probably is one of the more important of these factors.

Small mollusks seemingly are eaten in addition to the basic diet; in no instance were they ingested to the exclusion of other animals. Their infrequency of occurrence in the stomachs as compared with the large number of several gastropod species present on the mud-flats indicates that as a group the mollusks are disturbed very little and are reduced almost insignificantly by predation of these shorebirds.

Insects and their larvae occur in a significant part of the stomachs involved. Especially in the plovers, sandpipers, and sanderlings, which feed over *Salicornia,* and on the perimeter of sand and mud-flats, is this group found prominently. Larvae of the Ephydridae, a dipteran family, were commonly found. Flies of this family are characteristic of salt and brackish water. The larvae, being relatively sedentary, form large groups, which are ideal food sources for wading birds. In season, these larvae must form a large part of the diet of the inland mud feeders (Fisher, N. Amer. Fauna No. 7, 1893:25-26).

Of importance was the finding of fish in the stomach contents of two genera of shorebirds. Very little has been known or even suspected regarding predator-prey relationships between these two groups. The fact that two individuals out of twenty-seven had eaten quantities of fish indicates that, while not a prominent food habit, the taking of fish could be a significant control of the mud burrowing goby, *Clevelandia.* These small fish are often found in great numbers, but their limited and specialized habitat largely precludes predation by the larger piscivorous fish. They are well protected except from the ciconiiform and charadriiform birds. The former assume a prominent role in predation of fish of the *Salicornia* and mud-flat areas. Predation by the charadriiforms on these same fish has previously been far underestimated. This goby inhabits mud covered with water to a depth which probably protects them from most shorter legged waders.

Predation on crabs, other than *Emerita* is uncommon in the shorebirds examined, except the willets, which apparently feed primarily in the *Salicornia* marshes. The crab taken exclusively by these willets was *Hemigrapsus,* which maintains very large populations in the saline marsh areas.

Algal filaments were found in the food masses of most birds feeding on the mud-flats. Whether they were ingested directly or taken in secondarily as a constituent of the polychaete stomach contents is not known.

Department of Zoology, University of California, Los Angeles, September 9, 1950.

Burrowing Owl with Jerusalem Cricket (*Stenopelmatus*).

One-half natural size.

Photograph taken by James A. Carson
near Palo Alto, California, July 10, 1950.

FROM FIELD AND STUDY

Biographical Note on Scopoli.—Reading the article by Todd on White-fronted Geese (Condor 52, 1950:63-68), I was slightly startled by the reference to Scopoli as an Italian. Perhaps the underlying reason was that I have usually seen his name as Johann Anton Scopoli and recalled the statement by Gilbert White of Selbourne that Scopoli was physician to the cinnabar miners in Carniola, from which I supposed he was an Austrian. Having looked him up in the more obvious sources (Encyclopedia Britannica, Poggendorf, and Enciclopedia Italiana), the story becomes more complicated and of some interest.

Giovanni Antonio Scopoli (so given by Poggendorf) was born June 3 or 13, 1727, at Cavalese in Venezia Tridentina, about 30 miles northeast of the city of Trento. The province of Trento was a German bishopric from 1027 to 1803. It has only been Italian (politically) from 1810 to 1814 and since 1918. Scopoli took two medical degrees, one at Innsbruck (1743) and the other at Vienna (1753). From 1754-1770 he was (as noted above) a physician at Idria in Carniola. Idria is about 30 miles northeast of Trieste. This region had long been Austrian but was Italian from 1918 to about 1945. Since then it has been Yugoslavian territory. While at Idria (1769) Scopoli described his *Branta albifrons*. Scopoli then went as professor of mineralogy and metallurgy to Schemnitz in Hungary and was imperial and royal coinage and mines councillor. He stayed here from 1770 to 1776. Schemnitz is now Banska Stiavnica in Czechoslovakia, about 70 miles east of Bratislava. Scopoli made his last move in 1776 and became, apparently for the first time, a geographical Italian. He went to Pavia in Lombardy where he was professor of chemistry and botany and died there May 8, 1788. Pavia was Austrian from 1746 to 1796 and did not become Italian until 1870.

I have seen no complete account of Scopoli's writings. Poggendorf gives the longest list. Aside from botany and zoology, he wrote on mineralogy, chemistry, and "physico-chemical medicine." The last seems to be what we now call industrial medicine. One of his titles in this field is "De morbis fossorum hydrargyri." Linnaeus named for him the solanaceous genus *Scopolia* from which scopolamine is derived.

It will be seen that during most of his active life Scopoli was not only not an Italian politically, but did not even live in places which could be considered geographically Italian. He considered himself Tyrolese. On page 69 of the reference given by Todd, I find that *B. albifrons* was described from a specimen in the museum of Count Francesco Annibale della Torre, but no locality data are given. I have not been able to trace this particular della Torre but it seems clear that he was of the family of the counts of Thurn and Valsassina. The two chief lines of this Bergamese family, Como-Vercelli and Villalta-Spessa, had been associated with the regions of Gorizia (near Idria), Carinthia, and Carniola since 1543 and 1664. On the whole, the evidence points to the type locality of *B. albifrons* as northeast of the head of the Adriatic, in Carniola.—CHARLES H. BLAKE, *Massachusetts Institute of Technology, Cambridge, Massachusetts, April 4, 1950.*

Breeding Status of the Ring-necked Duck in Washington.—According to the Check-list of North American Birds (1931, p. 50), Ring-necked Ducks (*Aythya collaris*) breed from central British Columbia, Alberta, Saskatchewan, Manitoba and western Ontario south to southern Wisconsin, northern Iowa, northern Nebraska, northern Utah, central Arizona and formerly, at least, to northern Illinois. No mention is made of Washington. Since 1947 I have conducted extensive surveys of waterfowl-breeding areas in eastern Washington. Henry A. Hansen, Waterfowl Biologist for eastern Washington in the State of Washington Department of Game, has worked with me since 1948.

In the last three years we have the following summer records of Ring-necked Ducks in the channeled scablands of the Columbia Plateau: one male, Adams County, July 16, 1947; two males, June 28, 1948, and one male, June 30, 1948, Grant County; four males, Turnbull National Wildlife Refuge, Spokane County, July 15, 1948; and one male, Lincoln County, July 26, 1948. No satisfactory records were obtained in this region in 1949.

On July 17, 1947, I observed a brood of seven young approximately one-third grown with an adult which is believed to have been this species (this female had a gray speculum). They were on a pothole which supported a heavy growth of spatterdock (*Nuphar polysepalum*). This pond was less than one acre in size in the yellow pine zone, one-half mile south of Badger Lake, Spokane County.

No specimens were collected. On August 14, 1947, I observed a female Ring-necked Duck with a brood of six downy young on Nile Lake, Pend Oreille County, in the mountainous northeast corner of the state (fig. 1).

In 1949, Henry Hansen and I spent a few days in both Stevens and Pend Oreille counties searching for this species (the area was not visited in 1948). On August 10, we counted 19 individuals on Nile Lake, Pend Oreille County, and 18 on White Mud Lake, Stevens County, the county to the west of Pend Oreille. In both cases most of the individuals were young, two-thirds to nearly full grown, accompanying adult females. At McDowell Lake, Little Pend Oreille National Wildlife Refuge, Stevens County, we observed an adult female with young over three-fourths grown and three adult males in breeding plumage. The ring on the bill was not evident with 7 × 35 binoculars. On August 11, 42 individuals (females and young nearly grown) were noted on Twin Lake, Stevens County. We observed, in all, 90 Ring-necked Ducks in the two counties. On August 27, I collected two juvenal female Ring-

Fig. 1. Nile Pond, Pend Oreille County, Washington. Note spadder dock (*Nuphar polysepalum*) in foreground.

necked Ducks at Nile Lake to verify field identifications. These are in the Charles R. Conner Museum at the State College of Washington. In all of the specimens observed at close range in the field with binoculars no light ring could be seen on their bills; the same was true of the two collected later.

In all instances Ring-necked Ducks found breeding in Washington occurred on lakes in coniferous regions from about 1600 to 3500 feet in elevation. In nearly every instance the lake supported considerable beds of spatterdock (*Nuphar*). J. A. Munro (personal communication, 1949) states that it has been his experience in the Cariboo region of northern British Columbia that the species prefers lakes "dominated" by *Nuphar*. David Munro (personal communication, 1949) also had found that Ring-necks were noted nearly always on sloughs which supported a heavy growth of *Nuphar*. The latter sloughs were on the flood plain of the Columbia River and also on the park-like terraces above the river in the East Kootenay Region, southeastern British Columbia. He also has a breeding record: adult with eight young, less than a week old, four miles west of Invermere, B.C., July 8, 1949.

The summer of 1941 was spent in study of birds in Stevens and Pend Oreille counties (see Yocom, Murrelet, 26, 1945:19-23). White Mud Lake was visited frequently and observations were made occasionally on Twin, Nile and other lakes in this mountainous region. Since Ring-necked Ducks were not seen on these lakes it appears reasonable to assume that this species, although known by Stanley Jewett (personal communication) to have bred on the Little Pend Oreille National Wildlife Refuge

in 1940, has increased considerably since 1941. The East Kootenay region of British Columbia was not known definitely to be a breeding area for this species until David A. Munro found a brood in 1949. Possibly records from both of these regions indicate relatively new breeding areas for this species.

Ring-necked Ducks are difficult to identify in summer. The males when in eclipse plumage lack the characteristic markings that make identification in winter and spring easy. The light ring behind the dark-tipped bill, which is quite obvious in winter and spring, was not evident on the young collected nor on the adults observed. Thus, in the field, it is difficult to distinguish female and young Ring-necked Ducks from Scaups in the summer months. The gray speculum of the Ring-necked Duck and the white speculum on the Scaup, however, are good identification characters at close range, or if the birds can be made to fly. Obviously this is of no value when the wing feathers are molted or when young are less than two-thirds grown. For the most part, Scaup found breeding in Washington were in the scabland lakes of the Columbia Plateau in relatively open country. Thus, the breeding ranges of the two species do not overlap greatly except possibly in the yellow pine zone in Spokane County. —CHARLES F. YOCOM, *State College of Washington, Pullman, Washington, May 10, 1950.*

An Anna Hummingbird Caught in a Spider Web.—On June 7, 1950, Charles E. Shaw of the San Diego Zoo's Department of Reptiles summoned staff members to witness a remarkable spectacle in a landscaped area directly behind the reptile house. An immature male Anna Hummingbird (*Calypte anna*) had become entangled in the web of an orb-weaver spider.

The bird was suspended by the left wing from a point that was nearly the center of a horizontal span of web measuring approximately nine feet from end to end and at a height of approximately

Fig. 1. Anna Hummingbird caught by a spider-web strand. Photograph taken by Jordan S. Roux.

seven and a half feet from the ground. Six diverging strands at one end of the span remained attached to the trunk of a Queen Palm, while the web was attached at the other end to a frond of a Burmese Windmill Palm by only a single strand. Whatever additional points of attachment may previously have existed had been torn loose by the bird's thrashing.

In an attempt to free itself, the bird, using the free right wing, often flew in a swinging circular manner and in so doing further bound the primaries of the enmeshed wing in the web. During its struggle, it called frequently, attracting another Anna Hummingbird which hovered in the vegetation nearby. In one instance the flying hummer, which appeared to be a female, approached to within two feet of the trapped bird.

For more than forty minutes the bird attempted unsuccessfully to free itself. With each successive effort, it became only more firmly entangled and it showed increasing signs of exhaustion. It seemed most unlikely that the bird would be able to free itself; consequently, Shaw cut the web, unwound the portion that had become wrapped about the bird's primaries, and released the hummer.—KEN STOTT, JR., *Zoological Society of San Diego, San Diego, California, June 16, 1950.*

Pioneer Starling Nesting in Eastern Oregon.—The first verified nesting of the Starling (*Sturnus vulgaris*) near La Grande, Oregon, took place in late May, 1950. The locality is the Arthur McCall ranch, four miles east of La Grande. The nest site was in an eastward facing flicker hole twelve feet up in a willow tree. Two and sometimes three Starlings were noted in the vicinity of the ranch in the winter and spring. Nesting activity began in early May. A nesting was first attempted in a tree cavity a few feet from the house, but this was abandoned for the other site. When the nest hole was discovered on May 24, the parents were already feeding young birds. Both parents actively fed the young, usually alternating in appearance at the nest, in both the morning and evening when observations were made. Each parent had its own direction of coming and going to feed the young. The "*plee*" notes of the adult are varied to announce arrival at the nest, or to express displeasure or alarm, as, for example, when the writer climbed the tree to examine the nest.

There were five young in the nest, at the bottom of the cavity, 15 inches from the bottom of the entrance hole.

On June 3 a young associate reached down the slanting cavity and lifted one out. This nestling fluttered away into the tall cheat grass surrounding the nest tree and was followed in quick succession by the other four. Later, a parent returned to the tree, examined the empty nest, and then flew to hover over some rye grass where apparently a young was hidden.

McCall had been advised to destroy the nesting Starlings in view of their reputation as a pest. However, he takes a naturalist's interest in being able to watch this historic nesting, especially since the settlement of this region by Starlings appears inevitable. In previous years the writer has collected winter visitant Starlings in the valley.

Of interest are some of the bird associates of the Starling in its Oregon locale. A few yards from its nest site and at the base of a cross-arm on an electric light pole, a pair of Western Kingbirds built a nest. Yellow-throats sing and preen in nearby willows. Marsh Hawks hover over the greasewood, pursued by Brewer Blackbirds. Red-winged Blackbirds, too, are present in low, wet places on the farm. Several species of swallows nest about the ranch buildings and Tree, Barn, and Cliff swallows have all been observed at the Starling nest tree. The one member of the avifauna that seems to be missing may have been the unwilling victim of the Starlings. In past years Red-Shafted Flickers nested on this place, but none was observed here this year.

The habitat in the area of the Starling nesting is a wind-swept sandy loam, with a water table usually less than two feet from the surface. Alkali tends to rise to the ground level, making a situation suitable for hummocks of greasewood (*Sarcobatus vermiculatis*) and for areas of rabbit brush (*Chrysothamnus* sp.) and pasture grasses.—CHARLES W. QUAINTANCE, *Eastern Oregon College, La Grande, Oregon, June 3, 1950.*

A Caracara in Colorado.—The available literature reveals no previous report of the Caracara (*Polyborus cheriway*) in Colorado. Thus, it is a matter of uncommon interest that a live Caracara was found in the spring of 1948 in this state, in Garfield County.

The bird was discovered by a young boy in a small alfalfa field owned by John Duplis of Glenwood Springs, Colorado, some time in either the month of April or May. Although it could run and flap its wings, take-off was not possible. It was placed in a chicken coop, remaining therein until removed by the writer in early January, 1950. At that time it was shipped to Robert J. Niedrach, of the Denver Museum. who had it placed in the Denver Park Zoo where it now resides.

The Duplis farm is quite small and is located on a little meander bench about 2½ miles above the town of Glenwood Springs on the Roaring Fork River which, in turn, is located at the confluence of the Roaring Fork River with the Colorado River. Both canyons at this point are somewhat narrow and precipitous.—CLYDE P. MATTESON, *Colorado Game and Fish Department, Grand Junction, Colorado, June 11, 1950.*

Some Observations of Birds in Southern Colorado.—It is not improbable that some of the water birds which Ryder (Condor, 52, 1950:133-134) reported breeding in the San Luis Valley and Wright's Ranch areas of southern Colorado in 1949 have actually bred for some years in that neglected region. The writer saw at least twenty Snowy Egrets (*Leucophoyx thula*) at Russell Lakes in this valley in the late afternoon of May 8, 1937; a flock of four White-faced Glossy Ibis (*Plegadis*

mexicana) also was seen, but the only grebe identified was the Pied-billed (*Podilymbus podiceps*), of which two were seen by the road. Among other birds seen were Cinnamon, Blue-winged and Green-winded teal, Red-head, Canvas-back, Lesser Scaup, Mallard, Gadwall, Shoveler ducks, and the Bank Swallow, the last two species being common. At least one Tree Swallow and at least four Water-pipits were still present.

The following day, on the Rio Grande west of Creede, all the ducks seen in the valley below on May 7 and 8 were again seen except the Pintail, Blue-winged Teal, Red-head, and Canvas-back. In addition, a male Ring-necked Duck (*Aythya collaris*) was seen, and a female was doubtfully identified; also about four Baldpates were seen. More surprising to me, however, was the altitude to which some small passerine birds ranged on these prairies. In the boreal zones two to three miles west of Wright's Ranch were seen two Say Phoebes (*Sayornis saya*), a Loggerhead Shrike (*Lanius ludovicianus*), a Yellow Warbler (*Dendroica aestiva*), a Lark Sparrow (*Chondestes grammacus*), and some four or five Brewer Sparrows (*Spizella breweri*). Another shrike was seen 20 miles west of Wright's Ranch.—ALLAN R. PHILLIPS, *Tucson, Arizona, June 17, 1950.*

Black-and-white Warbler in Santa Clara County, California.—On June 10, 1950, a singing adult male Black-and-white Warbler (*Mniotilta varia*) was collected on Stevens Creek, 12 miles westsouthwest of San Jose, Santa Clara County, California. The bird was under observation for one hour and 15 minutes before being taken. During this period it sang at regular intervals and foraged mainly in coast live oaks (*Quercus agrifolia*). The bird remained within an area of approximately three acres and made a complete circle in the time it was observed. The specimen had enlarged testes, measuring 5 mm. in length, and showed heavy fat deposits in the abdominal area and along all feather tracts.

Acknowledgements are due Milton L. Seibert and Raymond E. Williams for their cooperation in securing the specimen, which is now deposited in the Museum of Vertebrate Zoology.—CHARLES G. SIBLEY, *San Jose State College, San Jose, California, June 25, 1950.*

Notes on the Birds of Mount Locke, Texas.—Mount Locke in the Davis Mountains of Jeff Davis County, Texas, is the site of the McDonald Astronomical Observatory of the University of Texas. It is a minor summit at 6800 feet elevation, 10 miles airline northwest of the town of Fort Davis and 10 miles east of Mount Livermore, which at 8400 feet is the dominating peak of the mountains. As described by L. C. Hinckley ("Vegetation of the Mount Livermore Area in Texas," American Midland Naturalist, 32, 1944:236-250), the Davis Mountains are geologically a part of the easternmost extension of the Front Range of the Western Cordilleras. The characteristic botanical formation of most of the area is woodland represented by various combinations of pine-oak-juniper groupings. On Mount Locke itself the dominant growth is scrub oak. Considerable piñon pine is also found, principally on north-facing slopes. The ground is exceedingly rocky but supports a fair cover of grass. The annual rainfall on Mount Locke is 20 inches, coming mostly in the summer months. The annual mean temperature is 57°F., varying from 42° in January to 71° in June.

The only ornithological record from the Davis Mountains of which I am aware is a brief note in Vernon Bailey's "Biological Survey of Texas" (N. Amer. Fauna No. 25, 1905:37). Van Tyne and Sutton's "The Birds of Brewster County, Texas" (Mus. of Zool., Univ. Mich., Misc. Pub. No. 37, 1937) covers definitively the lower and less rugged terrain 25 miles and more southeast of Mount Locke as well as the mountainous region 120 miles to the southeast.

The writer of the present notes lived on Mount Locke intermittently in the years 1939 to 1942 and 1946 to 1947 and made observations on birds chiefly in the spring season. The observations are restricted to the summit region and to the upper slopes of the mountain. Fall records are lacking altogether. Most of the birds resident on the mountain do not spend the winter on the summit proper where the observatory and accompanying residences are located.

Cathartes aura. Turkey Vulture. Vultures are continuously in evidence after they arrive in the middle of March. They roost in large numbers on the sides of Mount Locke.

Buteo jamaicensis. Red-tailed Hawk. A pair nested on the southern slope.

Alectoris graeca. Chukar Partridge. An individual appeared once. The species has been introduced on a ranch about 20 miles away.

Cyrtonyx montezumae. Mearns Quail. This species is probably resident on the mountain, although it is seen relatively infrequently. Two quail on being flushed killed themselves by flying head-on into

the large observatory dome, which gleams brightly with aluminum paint and could have been mistaken for the open sky.

Columba fasciata. Band-tailed Pigeon. A single individual was seen on Mount Locke in June. It is probably more abundant in the higher mountains where more heavily wooded areas are to be found.

Zenaidura macroura. Mourning Dove. Heard regularly at lower altitudes, but rarely comes to the top of the hill.

Geococcyx californianus. Road-runner. A single individual appeared in the winter. According to Van Tyne and Sutton, the Road-runner was not found above 5200 feet elevation in the Chisos Mountains.

Phalaenoptilus nuttallii. Poor-will. Heard at night regularly in the spring. The earliest date noted was April 18.

Chordeiles minor. Nighthawk. Nighthawks are very active around the observatory dome at dusk and dawn, starting about the first of May. They are attracted principally by the immense numbers of large moths that plague Mount Locke from May through October.

Archilochus alexandri. Black-chinned Hummingbird. Black-chinned and Rufous were the only hummingbirds identified. The Black-chinned is the common breeding hummingbird on Mount Locke. April 20 is the earliest date hummingbirds were seen.

Selasphorus rufus. Rufous Hummingbird. In the summer of 1941 a large number of maguey plants sprouted on the summit. Starting about the first of July, they were the regular feeding ground of six or more Black-chinned Hummingbirds. About July 20 a similar number of Rufous Hummingbirds arrived. For approximately a week there was a continuous battle among the hummingbirds around the magueys. The Rufous Hummingbirds were considerably more aggressive and drove off the Black-chins, whereupon the Rufous took up fighting among themselves.

Colaptes cafer. Red-shafted Flicker. Not uncommon in the early spring, from late February to April.

Dryobates scalaris. Ladder-backed Woodpecker. This bird appeared regularly and may be resident on the slopes of the mountain.

Tyrannus melancholicus. Tropical Kingbird. This is the only bird seen on Mount Locke not included in Van Tyne and Sutton's list of birds of neighboring Brewster County. While not as numerous or conspicuous as the Cassin Kingbird, it was seen regularly after its arrival, which appears to be a bit earlier in March than that of the Cassin. [Editors' note: specimens supporting this unusual record should be sought.]

Tyrannus vociferans. Cassin Kingbird. For much of the time in the spring and summer, Cassin Kingbirds are the most conspicuous birds around the summit of Mount Locke, both audibly and visually. They appear in numbers around the dome on the lookout moths.

Myiarchus cinarascens. Ash-throated Flycatcher. These birds are numerous in spring and summer. April 6 is the earliest date recorded.

Empidonax difficilis. Western Flycatcher. Empidonax flycatchers were seen at the summit on several occasions from April to August. The only definite identifications were of this species.

Contopus richardsonii. Western Wood Pewee. The spring of 1947 appears to have been particularly favorable for flycatchers on Mount Locke. Pewees were in evidence regularly during May.

Nuttallornis borealis. Olive-sided Flycatcher. Regularly distributed over the slopes of Mount Locke in late May and June, being more numerous in 1947 than in the earlier years.

Pyrocephalus rubinus. Vermilion Flycatcher. Seen once in August a couple of hundred feet below the summit.

Tachycineta thalassina. Violet-green Swallow. From mid-April until early June small groups occasionally were seen about Mount Locke.

Aphelocoma coerulescens. Scrub Jay. Scrub Jays are common residents.

Parus atricristatus. Black-crested Titmouse. Common residents. For a considerable period in May these birds are the most persistent singers on Mount Locke.

Psaltriparus minimus. Bush-tit. Flocks of Bush-tits work across the summit of Mount Locke regularly. Some probably nest there. The majority of the Bush-tits seen had no conspicuous dark

marking around the eye. On a few occasions the dark cheek patches associated with *P. melanotis* were noted.

Sitta carolinensis. White-breasted Nuthatch. Nuthatches are relatively uncommon on Mount Locke, although they were seen at all seasons.

Thryomanes bewickii. Bewick Wren. A common resident. Its songs are among those most frequently heard.

Catherpes mexicanus. Canyon Wren. In evidence visibly and audibly at all times. Although its song frequently echoes in the canyons, it is heard even more regularly around the buildings. These birds appear to prefer nesting in locations where there is plenty of activity: the rafters of the observatory garage, with trucks and cars going in and out; the ceiling of the machine shop, where they fly through two doorways to reach the nest; the rocker arm of a large pump which provides well water for the observatory; the chassis of my car behind the gas tank. The pump operates but a small portion of the time. When it was running, its motion did not appear to bother nesting activities. The nest under my car was so well built that it remained in perfect condition after a rough trip of 2000 miles. Although this nest was started while the car was in a garage, parking it outside 30 feet away did not discourage the builders, nor did removing the car from the mountain for a whole day.

Salpinctes obsoletus. Rock Wren. This wren also nests on the summit of Mount Locke, but is found more frequently on the lower rocky slopes.

Mimus polyglottos. Mockingbird. From 1939 through 1942 Mockingbirds were not encountered. In 1946 and 1947, however, they moved up to the summit by the second week in May and were common all over the mountain, dominating the vocal picture much of the time, particularly at the lower elevations. The handful of residences at the observatory does not offer shrubs and trees for them.

Sialia mexicana. Western Bluebird. Found at the lower elevations through the year, becoming numerous around the summit in the latter part of the summer. One season bluebirds fed extensively on the moths around the dome, coming into competition with the Cassin Kingbirds. The kingbirds spent their energy chasing the bluebirds, while the latter concentrated on the moths.

Regulus calendula. Ruby-crowned Kinglet. Heard on a few occasions in March and April.

Dendroica auduboni. Audubon Warbler. Solitary birds were seen on the summit throughout May.

Icterus parisorum. Scott Oriole. Fairly common from the latter part of May on. In the spring of 1947 the three or four singing males around Mount Locke and the one seen elsewhere in the Davis Mountains all were in the plumage of year-old males. In each case black appeared only on the throat instead of extending around the head and down the back. These parts were olive.

Piranga flava. Hepatic Tanager. These birds arrive on the summit about May 1, and thereafter are among the common singing birds about the mountain at all elevations. One bird that sang precisely like a male *P. flava* had a much different appearance. Reddish coloring appeared only on its cap, instead of being the dominant color. The throat was light yellow, the rest of the underparts darker yellow, the back as of a female tanager. Perhaps this was a yearling male.

Pheucticus melanocephalus. Black-headed Grosbeak. Grosbeaks arrive a bit later than the tanagers, and are about as common on the summit, although less so lower down. Their richer song is heard less regularly than that of the tanagers, particularly during the day.

Guiraca caerulea. Blue Grosbeak. A single bird was seen on Mount Locke in August.

Carpodacus mexicanus. House Finch. As in the case of the Mockingbirds, House Finches had not been seen near the summit in the earlier years. In 1946 and 1947 a few individuals appeared, apparently spilling over from the abundant population lower down.

Pipilo fuscus. Brown Towhee. Ubiquitous residents on Mount Locke, being nearly as continuously in evidence as they are in favorable locations in California.

Aimophila ruficeps. Rufous-crowned Sparrow. This is the only sparrow, in addition to the Brown Towhee, resident on the mountain. It is encountered everywhere and is a consistent early-morning singer throughout the spring.

Junco oreganus. Oregon Junco. Seen in early spring in 1942, but definitely not present in March, 1946.

Junco caniceps. Gray-headed Junco. Seen irregularly in winter and early spring of 1942 until April 15. They did not appear around the summit in March and April, 1946.

Spizella passerina. Chipping Sparrow. These birds are seen at all seasons at the lower elevations. They move up to the summit in the summer and become fairly common.—DANIEL M. POPPER, *Mount Hamilton, California, July 25, 1950.*

Duck Hawks Nesting in Colorado.—Although the Duck Hawk (*Falco peregrinus*) has been reported nesting in two localities in Colorado, it seems desirable at this time to place on record a third and more northern nesting location in the state. Sclater (A History of the Birds of Colorado, London, 1912) wrote of a pair that nested in the Garden of the Gods for five years. More recently Bailey and Niedrach (Auk, 63, 1946:253) reported a pair they observed in 1943 nesting at Chimney Rock between Pagosa Springs and Durango in southwestern Colorado.

On April 25, 1950, Victor Favier reported a hawk or falcon nest on the back of the third Flatiron, a prominent rock formation just south of Boulder. The next day he and I visited the site fully expecting to see Prairie Falcons but were surprised to find a pair of Duck Hawks with four eggs. Copulation was observed at this time. The nest was on a ledge about sixty feet from the ground. The site was visited on May 9, 14, and 21. It was next visited about two weeks later when three well-developed young were present. The fourth egg was infertile. The three young were banded at this time. On June 24 a young female was taken from the nest for use in falconry; this is the last time the birds were observed.

The attitude of the birds toward a pair of Prairie Falcons (*Falco mexicanus*) may be of interest. The nest of the Prairie Falcons was situated approximately two hundred yards from but not in direct view of the Duck Hawk site. At the time the nest of these birds was discovered it contained five young slightly older than those of the Duck Hawk. When this nest was approached the Prairie Falcons flew about noisily, much more so than we had ever seen the Duck Hawks do. At one time when I had my eyes fixed on the crying bird a Duck Hawk streaked by almost faster than my eyes could follow and only a few feet over the Prairie Falcon. This performance was repeated at least three times. This was the first time we had ever seen the Duck Hawks take any notice of the Prairie Falcons. These actions and the proximity of the two nests would seem to contradict the conjecture of Webster (Auk, 61, 1944:609-616) that the Duck Hawk has been crowded out by the Prairie Falcon as a resident breeding bird in Colorado.—NORMAN R. FRENCH, *University of Colorado Museum, Boulder, Colorado, August 1, 1950.*

Corrections Concerning Data on Alaskan Birds.—In a recent list of birds from Wrangell, southeastern Alaska (Condor, 52, 1950:36) I made an error, whereby my bibliographic carelessness reflected on the accuracy of John Burroughs (Narrative of the Expedition *in* Harriman Alaska Expedition, 1, 1902:40). Contrary to my previous statement, Ridgway (Bull. U. S. Nat. Mus., 50, II, 1902: 725) *did* report a Redstart (*Setophaga ruticilla*) from Alaska—"Point Gustavus, Glacier Bay," undoubtedly the same specimen referred to by Burroughs. Therefore, the specimen collected and others seen by me represent the second record of the Redstart from Alaska. It is noteworthy that both records are from the mainland coast of the southeastern part of the territory. I suggest that the Redstart, like several other species (Swarth, Proc. Calif. Acad. Sci., ser. 4, 23, 1936:68), reached the coast rather recently, by way of the large mainland river valleys, from the east.

The time is opportune to correct some errors in my papers on the Black Oyster-catcher (*Haematopus bachmani*) in Alaska, errors dealing with identification of seashore invertebrates:

Condor, 43, 1941:175 and 178; Wilson Bull., 53, 1941:142. For *Acmaea scutum* read *Acmaea pelta* (= *Acmaea cassis pelta*).

Condor, 43, 1941:175 and 178, lines 31 and 42. For *Mitella polymerus* read *Balanus cariosus.*

Condor, 43, 1941:178, line 39. To the associes *Mytilus californianus, Pisaster ochraceus, Mitella polymerus* add *Acmaea digitalis* and *Balanus cariosus.*

Wilson Bull., 53, 1941:142. To the associes *Mytilus californianus, Pisaster ochraceus,* and *Mitella polymerus* add *Acmaea digitalis* and *Balanus cariosus.*

Apparently my identifications of *Balanus glandula* and other invertebrates were correct, although it should be noted that my taxonomy followed Ricketts and Calvin (Between Pacific Tides, 1939: 1-320).—J. DAN WEBSTER, *Hanover College, Hanover, Indiana, August 16, 1950.*

NOTES AND NEWS

The Twenty-second Annual Meeting of the Cooper Ornithological Club will be held at Asilomar, California, on the Monterey Peninsula, April 20 to 22, 1951, under the sponsorship of the Southern Division. Plan now to attend. A call for contributions to the scientific program will soon be issued.

After 42 years of service in the business management of the Cooper Ornithological Club, W. Lee Chambers has declared he must be relieved of his duties. Planning and developing of Club affairs and the performance personally of all manner of detailed business chores have been the avocation and the generous contribution of Mr. Chambers, compensated for only by the knowledge that he has been a larger factor in building a worthy scientific organization.

The Board of Directors has recently named the following corps of Business Managers to conduct the affairs of the Club in 1951: C. V. Duff, Business Manager, in charge of promotion; Ed N. Harrison, Assistant Business Manager; Thomas R. Howell, in charge of sales of publications; J. R. Pemberton, chairman of the endowment committee; Sidney B. Peyton, Treasurer; and W. J. Sheffler, chairman of the investment committee.

The colored frontispiece, the eleventh in the series of paintings by Andrew Jackson Grayson published in The Condor, appears through the generosity of Mr. Earl B. Gilmore. It portrays the Fulvous Tree-duck (*Dendrocygna bicolor*). The following paragraph of comments is taken from Grayson's notes on this species.

"At the conclusion of the rainy reason, or the month of October, Fulvous Tree Ducks make their appearance in the vicinity of Mazatlan, San Blas and southward in large flocks, inhabiting the fresh water ponds and lakes in the coast region or Tierra Caliente during the entire winter or dry months, subsisting principally upon the seeds of grass and weeds and often at night visiting the cornfields for grain . . . . Although its geographical range is confined within the limits of the tropics, yet this species has its seasons of periodical migrations from one part of the country to the other. During the month of April their well known and peculiar whistle may be heard nightly as they are passing over Mazatlan in apparently large flocks going northward. Some, however, remain and breed in the state of Sinaloa. I found young broods near San Blas that were unable yet to fly as late as the month of November . . . . Whilst in the City of Mexico during the months of February and March, I saw none of these ducks in the market, where a great many of our northern species were to be seen every morning. Nor have I met with it on the high central plains."

Rollo H. Beck, ornithological explorer of remarkable skill, energy, and daring, died on November 22, 1950, at eighty years of ago. The excellent account of his life in Murphy's "Oceanic Birds of South America" (pp. 3-25) should be read in full to gain a true understanding of his fascinating career.

In order to perpetuate the memory of Dr. Frank M. Chapman and to continue his influence, a memorial fund under control of The American Museum of Natural History was established after his death in 1945 by Mrs. Elsie M. B. Naumburg and her husband, Walter W. Naumburg. Many of Dr. Chapman's friends and admirers have since contributed to this fund, which has grown sufficiently to permit a grant or grants to be made from the income. The Frank M. Chapman Memorial Committee is happy to announce that the first awards may be allotted in the year 1951.

Applications for fellowships should be addressed to the Chapman Memorial Fund, in care of the Department of Birds of the American Museum of Natural History, New York 24, N. Y. Applicants should state their training and experience and describe the nature and the scope of the proposed project as well as the plan of procedure, previous work on the project (if any), and the amount of financial aid required. They should also supply the names of one or more sponsors.

Projects that are eligible under the provisions of the Chapman Memorial Fund include field expeditions, travels undertaken for the purpose of intensive studies of behavior of species of birds or of bird colonies, and support of laboratory or museum studies—in fact, almost any phase of sound ornithological research. A sum of approximately $2000.00 will be available for the first grants.

The American Museum of Natural History will be responsible for judging the qualifications of the applicants. Any necessary collections made during the tenure of a Chapman Fellowship will be deposited in the American Museum. Applications must be received before June 1, 1951.

The late Florence Merriam Bailey bequeathed to the Cooper Club her collection of bird art (see back cover of this issue for listing) and $500, both for the Club's Endowment Fund. The grateful appreciation of the Club is herewith expressed for the aid she has thus given to our ornithological undertakings.

On approval of the Board of Directors, the Editor has invited a group of ornithologists removed from the center of principal editorial activity in Berkeley to serve as consultants and advisors with respect to manuscripts and Condor affairs. The following have agreed to serve on this advisory committee in 1951: David E. Davis, Herbert G. Deignan, Jean M. Linsdale, George Lowery, Jr., Ernst Mayr, and Robert W. Storer.

COOPER CLUB MEETINGS

SOUTHERN DIVISION

OCTOBER.—The monthly meeting of the Southern Division of the Cooper Ornithological Club was held October 24, in Hancock Hall, University of Southern California, Los Angeles. The following names were proposed for membership: Mrs. Gladys M. Caprini, 1807 Sacramento St., Vallejo, Calif., by J. McB. Robertson; John Bowman Davidson, P. O. Box 276, Corona del Mar, Calif., by Mrs. J. Q. Burch; Paul A. Florian, 427 W. Colorado, Glendora, Calif., and Dr. Everitt Vincent Payne, 538 East "I" St., Ontario, Calif., both by K. E. Stager; and Francis Raymond, 1029 Cliff Dr. (P. O. Box 2371), Laguna Beach, Calif., by Wade Fox, Jr.

Dr. Robert T. Moore was unanimously elected to Honorary Membership.

Thomas R. Howell, Curator of the Dickey Collections, University of California at Los Angeles, spoke on "The Natural History and Relationships of the Western Sapsuckers."—DOROTHY E. GRONER, *Secretary*.

NORTHERN DIVISION

OCTOBER.—The monthly meeting of the Northern Division of the Cooper Ornithological Club was held in Life Sciences Building, University of California, Berkeley, on October 5, 1950. The following were proposed for membership: Willard D. Hartman, Dept. of Zoology, Univ. of Calif., Berkeley, Calif., by F. A. Pitelka; Joseph J. Zucca, 618 Sanchez St., San Francisco 14, Calif., by Robert T. Orr.

H. L. Cogswell reported a Gray-backed Shearwater on September 10 off the Farallones, a Pectoral Sandpiper at Bay Farm Island on September 24, and a Prairie Falcon at Sears Point on September 30.

Gordon W. Gullion presented the results of his two years research on the behavior of the American Coot in the San Francisco Bay region, illustrating his talk with many very excellent Kodachrome slides.—HENRY E. CHILDS, JR., *Secretary*.

NOVEMBER.—The monthly meeting of the Northern Division of the Cooper Ornithological Club was held in Life Sciences Building, University of California, Berkeley, on November 2, 1950. George Piternick, 2310 Ellsworth St., Berkeley 4, was proposed for membership by F. A. Pitelka.

Dr. H. C. Bryant, former president of the northern division, spoke briefly on bird migration at Grand Canyon National Park.

E. Lowell Sumner, speaker of the evening, discussed the wildlife of the Channel Islands National Monument.—HENRY E. CHILDS, *Secretary*.

DECEMBER.—The monthly meeting of the Northern Division of the Cooper Ornithological Club was held in Room 2503 Life Sciences Building, University of California, Berkeley, on December 7, 1950. The following were proposed for membership: Laurence J. Thompson, 225 Manhattan Beach Blvd., Manhattan Beach, Calif., James Whitehead, Mt. Tamalpais State Park, Mill Valley, both by Frank A. Pitelka; Clare M. Creighton, 1070 3rd St., Hermosa Beach, Calif., by A. H. Miller; Hubert R. MacCarthy, 1006 W. 19th St., North Vancouver, British Columbia, by H. E. Childs.

Dr. Pitelka reported for the Research Committee and announced that the project to be undertaken for the next year was to be devoted to nesting records of the Allen Hummingbird and the Bush-tit. He illustrated the use of such data with a graph showing the breeding seasons of hummingbirds in the Santa Barbara area where the Anna, Allen, Black-chin, and Costa hummingbirds occur.

President Kelly appointed John Chattin, Frank Pitelka, and E. Lowell Sumner, Jr., to the nominating committee.

Mr. Curl reported the Clark Nutcracker, Evening Grosbeak, and Townsend Solitaire at Fremont Peak State Park on November 11.

Dr. Charles G. Sibley spoke on his recent field experiences in western Mexico and showed Kodachrome slides taken on the trip.—HENRY E. CHILDS, JR., *Secretary*.

For Sale, Exchange and Want Column—Each Cooper Club member is entitled to one free advertising notice in any issue of The Condor. Notices of over five lines will be charged for at the rate of 25 cents per line. For this department, address Sidney B. Peyton, R. R. No. 2, Box 260, Fillmore, Calif.

FOR SALE—Wildlife photographs from the western states. Naturalists' shots of grouse, ducks, geese, dippers, as well as life history series of Rocky Mountain big game mammals. Black and white or color. Small prints for publication $2.00 or 8×10 art prints for framing at $8.00 and up. Write for your needs.—MRS. C. M. BOYD, *Box 132, Fort Logan, Colorado.*

BINOCULAR SERVICES—As binocular specialists since 1923, we offer expert service and technical information. If your glass needs repair or coating, send it in for free estimate. If you need a new one, send for free list of glasses from $12 to $175—all guaranteed adjusted to U. S. Government tolerances and sent on 10 days' free trial. Liberal trade-in. For details how to use, choose and check a binocular, send 25¢ for illustrated booklet (reprint of our articles recently published in The American Rifleman). We also check glasses without charge and answer questions personally.—MIRAKEL REPAIR CO., *Mount Vernon 15, New York.*

WANTED—For educational use, skins in good condition, of Sora, Red-headed Woodpecker, Wood Thrush, Connecticut Warbler, Bobolink (male), Baltimore Oriole (male and female), Rose-breasted Grosbeak (female), Cardinal (female), Indigo Bunting (female), Goldfinch (female), Grasshopper, Chipping, Field and Swamp sparrows.—E. ALEXANDER BERGSTROM, *37 Old Brook Road, West Hartford 7, Connecticut.*

FOR EXCHANGE—Back numbers of The Auk, Canadian Field Naturalist, and Murrelet, for full sets of eggs of nocturnal and diurnal birds of prey of the Southern States and Mexico.—S. J. DARCUS, *R. R. 1, Box 2206, Penticton, B. C., Canada.*

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WANTED—"A Bibliography of Scarce or Out of Print North American Amateur and Trade Periodicals Devoted More or Less to Ornithology," by Burns. The Oologist, vol. LVII, 1940, no. 12, and vol. LVIII, 1941, no. 11. California Fish and Game Bulletin, 1915, nos. 1 and 2; 1918, no. 1; 1922, no. 2.—ED N. HARRISON, *P.O. Bin No. 10, Encinitas, California.*

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